WATER RESOURCES AUTHORITY
MASSACHUSETTS

Secondary Treatment Facilities Plan

Volume IV

Inter-Island Conveyance System

DRAFT REPORT

October 22, 1987

How to Use the Secondary Treatment Facilities Plan

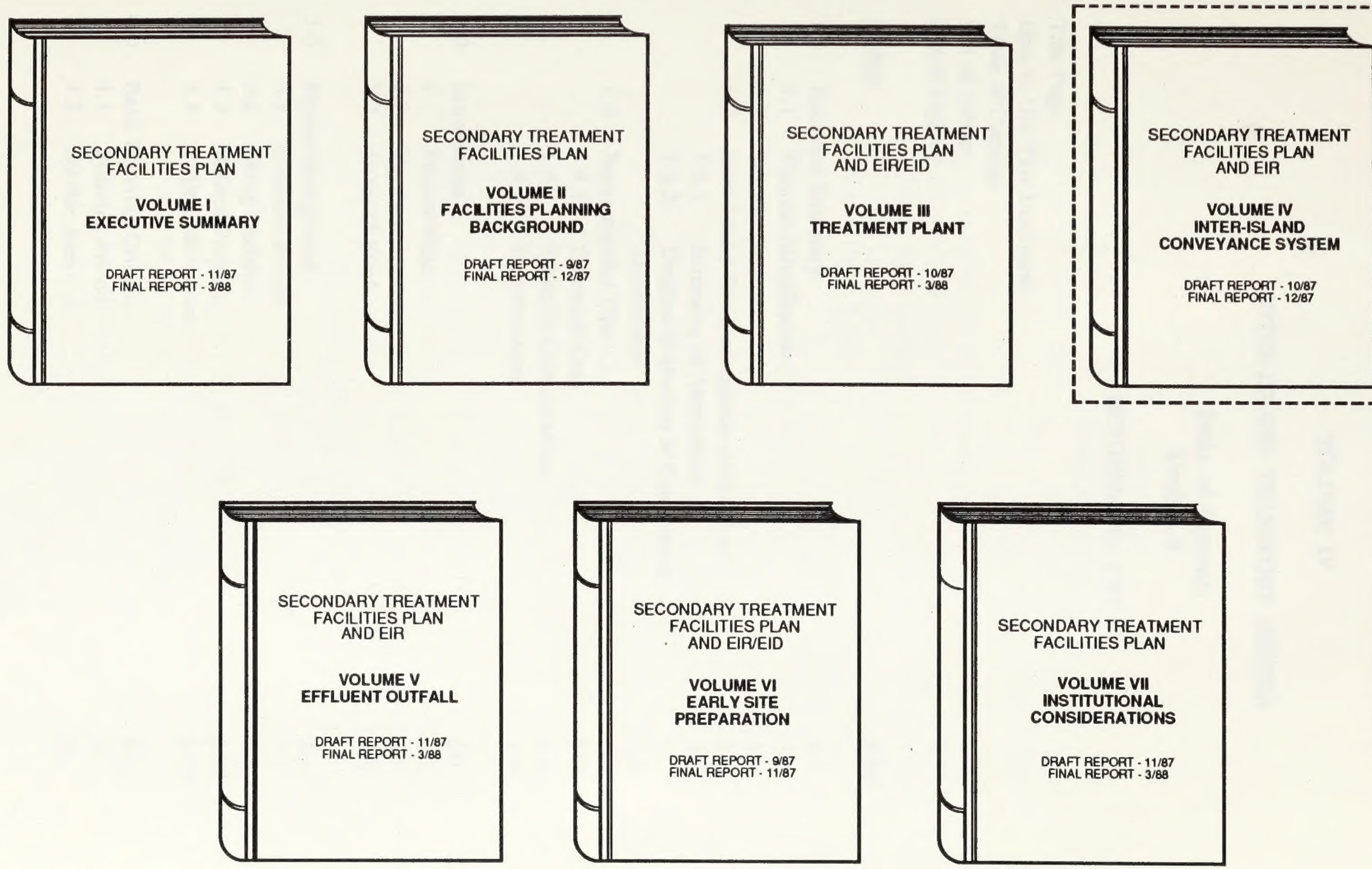
The Secondary Treatment Facilities Plan is organized into seven volumes.

The major components of the Secondary Treatment Facilities Plan are: Treatment Plant, Inter-Island Transport System, Effluent Outfall, and Early Site Preparation.

The Secondary Treatment Facilities Plan document consists of a stand-alone volume for each of these components as well as volumes for Facilities Planning Background, Institutional Considerations, and Executive Summary.

Each volume may be referenced to find complete planning information pursuant to that project component. The seven volumes are numbered as follows:

Volume I	Executive Summary
Volume II	Facilities Planning Background
Volume III	Treatment Plant
Volume IV	Inter-Island Transport System
Volume V	Effluent Outfall
Volume VI	Early Site Preparation
Volume VII	Institutional Considerations



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DEER ISLAND
SECONDARY TREATMENT FACILITIES PLAN
VOLUMES

SECONDARY TREATMENT FACILITIES PLAN

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Appendices

A. Ambient Sound Pressure Levels
September 1986, Winthrop, MA.

B. Statistical Ambient Sound Levels
Point Shirley, Winthrop, MA.

C. Letter from Valerie A. Talmage,
Massachusetts Historical Commission,
to Michael Deland, U.S. EPA,
December 6, 1985.

D. Archaeological Documentary Research Undertaken
by Public Archaeology Laboratory, Inc.

E. Traffic Impact Analysis Methodology.

F. Offshore Geotechnical Investigation and Design Criteria
for the Inter-Island Transport System.

Section 1

1.0 SUMMARY

1.1 VOLUME IDENTIFICATION

The Inter-Island Conveyance System is Volume IV of the seven-volume Secondary Treatment Facilities Plan.

1.2 INTRODUCTION

The existing Massachusetts Water Resources Authority (MWRA) wastewater system consists of a North and a South System. Wastewater from the South System is currently treated at Nut Island; wastewater from the North System is currently treated at Deer Island. New primary and secondary treatment facilities, which will serve both the North and South Systems, will be located on Deer Island. Consolidation of treatment at the new Deer Island treatment facilities will require a means of transporting 360 million gallons per day (mgd) of South System wastewater from Nut Island to Deer Island, a distance of about 5 miles. A new South System pump station will also be required to lift the wastewater into the new treatment plant.

Following consolidation, the existing treatment facilities on Nut Island will be decommissioned. Preliminary treatment, consisting of screening and grit removal, will be provided at a new headworks on Nut Island, as discussed in Volume III, Treatment Plant.

1.3 INTER-ISLAND CONVEYANCE SYSTEM ALTERNATIVES

The inter-island transport conduit could be constructed by any of three methods: marine pipeline, sunken tube, or deep rock tunnel.

A marine pipeline would be built by conventional marine construction methods. In deep water, barge-mounted equipment would be used to trench, lower and install sections of pipe in lengths of approximately 16 ft, and place backfill and stone cover protection as required. In shallow near-shore areas (surf zone), a stationary trestle supporting a traveling crane on rails would be constructed to perform the same duties as the barges.

The sunken tube method of construction has been successfully used on a number of underwater vehicular tunnels, particularly in the Chesapeake Bay area. This type of construction is considered potentially cost-effective for diameters over 12 ft, which is only slightly larger than that anticipated for the inter-island conduit. The tube would be fabricated from steel in lengths of approximately 200 ft. The tube would be outfitted with interior and exterior concrete, towed into position over an excavated trench, and sunk into the trench. Trench excavation, stone bedding, backfill, and cover protection would be similar to that of the pipeline construction.

The deep rock tunnel alternative is also a conventional method of construction that has been used successfully in the Boston area and throughout the world. Vertical access shafts would be

constructed on land at the beginning and at the end of the tunnel. These shafts would penetrate through the overburden and into sound rock, terminating approximately 200 to 300 ft below the surface. The tunnel would be excavated by a tunnel boring machine (TBM) or by drill and blast techniques, and lined with concrete.

1.3.1 SCREENING OF ALTERNATIVES

There are limitations on the use of both the marine pipeline alternative and the sunken tube alternative for the inter-island transport system. The most important limitation is caused by the fact that the conduit must cross the main Boston shipping channel along the route from Nut Island to Deer Island. The crossing will be in President Roads. A large-diameter pipe or sunken tube extending across the shipping channel is not practical for three reasons.

First, the water depths in the channel are 60 ft to 70 ft below mean low water. Due to burial and cover requirements to protect the pipe against potential damage from anchor dragging and scour from wave and tidal forces, the bottom of a pipeline trench would be approximately 80 ft to 90 ft below mean low water. Since the pipeline must slope continuously downward toward its terminus on Deer Island to prevent solids deposition, a pipeline trench across Deer Island would be well over 100 ft deep. This would place the lower 15 ft to 25 ft of the excavation into rock. The length of the trench would be over 2,000 ft. long. The depth of cut, length of trench, and required rock excavation make these alternatives undesirable.

Secondly, since all ship traffic to and from Boston passes through President Roads, major pipeline construction across this busy but narrow shipping lane would require careful coordination with the U.S. Coast Guard to avoid unsafe conditions during construction. Although this type of construction is possible, it is not desirable if alternative means are available.

Finally, although there are currently no plans to do so, it is conceivable that the shipping channel may be deepened during the project life or beyond. If this occurs, another conduit would have to be constructed.

For these reasons, the deep rock tunnel is the only method of construction considered feasible for crossing the Boston shipping channel. It would be possible, however, to construct a pipeline or sunken tube between Nut Island and Long Island with a tunnel from Long Island to Deer Island.

1.3.2 DETAILED EVALUATION OF CONVEYANCE ALTERNATIVES

The following three inter-island conduit alternatives were selected for detailed evaluation:

- Alternative 1 - A single deep rock, concrete-lined tunnel with vertical access shafts located on Nut Island and Deer Island.

- o Alternative 2 - A single concrete marine pipeline from Nut Island to Long Island, and a single deep rock, concrete-lined tunnel from Long Island to Deer Island, with vertical access shafts on both Long Island and Deer Island.

- o Alternative 3 - A single concrete lined sunken tube from Nut Island to Long Island and a single deep rock, concrete-line tunnel from Long Island to Deer Island, with vertical access shafts on Long Island and Deer Island.

As noted earlier, a new South System pumping station is also required. Although it was found to be technically feasible to locate the pumping station on either Nut Island or Deer Island, the Deer Island location was selected because the necessary pumping station support facilities will be constructed on Deer Island as part of the new wastewater treatment plant support facilities. The principal support facilities include redundant sources of electrical power, spare parts storage, and maintenance facilities. If the pumping stations were located at Nut Island, separate support facilities would have to be constructed, operated, and maintained.

The South System pumping station must be capable of pumping flows ranging from 80 mgd to 360 mgd. To handle this wide range of flows and resulting wide variation in heads, variable-speed pump drives are required. Three possible drive alternatives include diesel engines, electric motors with variable-frequency drives, and electric motors with eddy-current couplings.

Diesel engines were screened from further consideration because MWRA is committed to utilizing electric motors whenever practical. Electric motors will result in quieter operations and, with redundant electric power supplies available, a high level of reliability. The following two variable-speed drive system alternatives were evaluated for the new pumping station.

- o Alternative 1 - Constant-speed electric motors connected to eddy-current couplings.

- o Alternative 2 - Variable-frequency drives connected in series with electric motors.

A summary of the alternative evaluation is contained in Tables 1.3-1 and 1.3-2.

1.4 RECOMMENDED PLAN

The recommended plan includes a deep rock, concrete-lined (either precast concrete sections or cast-in-place concrete) tunnel connecting Nut Island and Deer Island (Alternative 1), and a pumping station located at Deer Island. The tunnel, with a finished inside diameter of 11 ft, will be constructed in competent rock approximately 200 ft to 300 ft below sea level. The deep rock tunnel will be connected through vertical shafts to the new headworks at Nut Island, as discussed in Volume III of the facilities plan, and to the new South System pumping station at Deer Island. One vertical shaft will be located at each island. All wastewater passageways

TABLE 1.3-1

SUMMARY OF ALTERNATIVE EVALUATION

Inter-Island Conveyance System Alternatives	Alternative 1 (Tunnel)	Alternative 2 (Pipeline/Tunnel)	Alternative 3 (Sunken Tube/Tunnel)
Description			
- 11 ft diameter tunnel	- 24,800 L.F.	- 12,600 LF of tunnel	- 12,600 L.F. of tunnel
- 2 16 ft diameter tunnel shafts	- Shafts at Deer Island and Nut Island	- Shafts at Deer Island and Long Island	- Shafts at Deer Island and Long Island
- 11 ft diameter conduit		- 14,300 L.F. of pipeline	- 14,300 L.F. of sunken tube
Costs ($ millions)			
- Present worth	- $63.0	- $113.0	- $172.0
- Project costs	- $83.0	- $148.0	- $225.0
- Annual operation and maintenance costs	- Minimal	- Minimal	- Minimal
Construction Schedule	- 36 months - Dependent upon rock characteristics	- 36 months - Dependent upon weather for pipeline portion - Tunnel dependent on rock characteristics	- 42 months - Dependent upon weather for sunken tube portion - Tunnel dependent on rock characteristics
Excess Excavation Spoils	- 197,000 yd^3 of tunnel spoils removed and used on Deer Island in vision/ noise landforms; 3000 yd^3 of shaft spoils removed and used on Nut Island	- 94;000 yd^3 of tunnel spoils removed and used in landforms; 2400 yd^3 of shaft spoils removed and used on Long Island	- 94,000 yd^3 of tunnel spoils removed and used in Deer Island landforms; 2400 yd^3 of shaft spoils removed and used on Nut Island
		- 1,500,000 yd^3 of dredged material unsuitable for trench backfiling use	- 1,500,000 yd^3 of dredged material unsuitable for trench backfilling use

TABLE 1.3-1

SUMMARY OF ALTERNATIVE EVALUATION

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Inter-Island Conveyance System Alternatives	Alternative 1 (Tunnel)		Alternative 2 (Pipeline/Tunnel)			Alternative 3 (Sunken Tube/Tunnel)		
Noise Control	Point Shirley	Great Hill	Point Shirley	Great Hill	L.I. Hosp.	Point Shirley	Great Hill	L.I. Hosp.
- Ambient	45 dBA	47 dBA	45 dBA	47 dBA	40dBA	45 dBA	47 dBA	40 dBA
- Silenced sheetpile driving	51 dBA	62 dBA	51 dBA	61 dBA	57 dBA	51 dBA	61 dBA	57 dBA
- Shaft construction	55 dBA	58 dBA	55 dBA		43 dBA	55 dBA		43 dBA
- Pipe or tube construction				42 dBA	43 dBA		46 dBA	43 dBA
Automobile Round Trips Per Day								
- Vertical shafts	- 25-30 at Deer & Nut Islands		- 25-30 at Deer, Nut, & Long Islands			- 25-30 at Deer, Nut, & Long Islands		
- Tunnel boring	- 175-185 at Deer Island		- 175-185 at Deer Island			- 175-185 at Deer Island		
- Tunnel lining	- 105-115 at Deer Island		- 105-115 at Deer Island			- 105-115 at Deer Island		
- Pipeline or sunken tube	(Busing and ferrying planned to mitigate on Deer Island)		- 20-25 at Nut and Long plus 15-20 to the barge pier (Busing and ferrying planned to mitigate on Deer Island)			- 20-25 at Nut and Long Island plus 25-30 to barge pier (Busing and ferrying planned to mitigate on Deer Island)		
Truck Round Trips Per Day to On-Island Piers								
- Vertical shafts	- 2-10		- 2-10 at piers plus 1-5 to Long Island			- 2-10 at piers plus 1-5 to Long Island		
- Tunnel boring	- 10-15		- 10-15 at piers plus 1-5 to Long Island			- 10-15 at piers		
- Tunnel Lining	- 10-15		- 10-15 at piers plus 1-5 to Long Island			- 10-15 at piers		
- Pipeline or Sunken Tube			- 1-5 at piers and Long Island			- 1-5 at piers and Long Island		

TABLE 1.3-1

SUMMARY OF ALTERNATIVE EVALUATION

Inter-Island Conveyance System Alternatives	**Alternative 1 (Tunnel)**	**Alternative 2 (Pipeline/Tunnel)**	**Alternative 3 (Sunken Tube/Tunnel)**
Fish, Shellfish and Other Marine Biota	None	- Temporary disruption of 46 acres of Benthic habitat	- Temporary disruption of 46 acres of Benthic habitat
Permitting	Modest Requirements	- Complex permitting due to dredging and potential conflicts with other on-water activities	- Complex permitting due to dredging and potential conflicts with other on-water activities
External Coordination	Minimal	- Extensive coordination with state/Boston for use of small area on Long Island and improved access to Long Island	- Extensive coordination with state/Boston for use of small area on Long Island, improved access to Long Island and construction staging area for sunken tubes
Demand for Unique or Scarce Resources	- Tunnel boring machine must be custom built requiring about 12 months; tunnel worker availability must be coordinated with effluent outfall and third harbor tunnel construction.	- Same as Alt 1 - 1,500,000 yd^3 of dredged material unsuitable for trench backfilling use; blasting of rock may be required.	- Same as Alt 1 plus initial sunken tube must be custom fabricated - 1,500,000 yd^3 of dredged material unsuitable for trench backfilling use; blasting of rock may be required.

TABLE 1.3-2

SOUTH SYSTEM PUMPING STATION ALTERNATIVES

	Alternative 1 (Eddy Current Couplings)	Alternative 2 (Variable Frequency Drives)
Construction schedule	36 months	36 months
Excavation spoils	30,000 yd^3 removed and used on Deer Island	30,000 yd^3 removed and used on Deer Island
Cost ($ millions)		
o Present worth	$38.0	$40.6
o Project costs	$37.5	$40.6
o Annual operation and maintenance costs	$1.3	$1.2

will be lined with concrete. The tunnel will follow a straight line from Nut Island to Deer Island, a distance of approximately 24,800 ft. The recommendation of the tunnel method was based on technical adequacy, cost considerations, environmental impact, and institutional considerations. (See Table 1.3-1)

The recommended South System pumping station to be built on the southern side of Deer Island will include six pumps, each rated at 90 mgd. All pumps will be driven by an electric motor through a variable-speed eddy-current coupling drive. As indicated, the Deer Island location was selected because the necessary pumping station support facilities, such as redundant major sources of electric power, will be available on Deer Island. Eddy-current couplings were selected over variable-frequency drives because of their lower cost.

1.4.1 ESTIMATED COST

The estimated project cost for the recommended plan is $120,500,000. The breakdown of this cost is $83,000,000 for the tunnel and vertical access shafts, and $37,500,000 for the South System pumping station. These costs reflect September 1986 prices and include capital construction costs and an allowance of 35 percent for engineering costs and contingency.

1.4.2 SCHEDULE CONSIDERATIONS

The milestone completion date for the inter-island transport system is December 1994. To perform the detailed design phase, including a comprehensive geotechnical field program, and to complete construction in accordance with this milestone, the detailed design phase must begin no later than December 1989. However, to allow for the possibility of finding unexpected rock conditions when conducting the geotechnical field program, it is recommended that the geotechnical investigations begin approximately one year earlier.

The CPM schedule that was developed by MWRA and entered by the federal court assumed that the new effluent outfall would begin accepting flows from the existing Nut Island Treatment plant through the inter-island transport system by March 1995. The South System pumping station will also have to be completed at that time. This early use of the new outfall would require the installation of a costly temporary connection between the South System pumping station and the new effluent outfall, for a four- to-eight-month period of time until the new primary treatment facilities would be completed in July 1995, and operational by January 1996. Because all of the alternatives now being considered for the effluent outfall will require a longer construction period than that allowed in the milestone schedule, the temporary connection to permit Nut Island plant effluent to discharge directly to the new outfall no longer appears to be feasible. A modification may be required in the milestone schedule to reflect this change.

1.4.3 ENVIRONMENTAL

The environmental impact assessment of the recommended plan has identified the incremental effects on land and marine resources attributed directly to construction of the inter-island transport system during the 1991 through 1995 period. The combined effects of these

construction facilities on Nut Island and Deer Island during the same period will be assessed in the Treatment Plant EIR/EID, Volume III. The effluent outfall construction will be assessed in Volume V. Overall, the recommended plan for the inter-island transport system will have only the following minor effects on land and marine resources:

- Continuous offsite construction noise levels predicted for the nearest residents at Shirley Point (Winthrop) and Great Hill (Hough's Neck) are approximately 10 dBA above existing ambient daytime noise.

- There are essentially no impacts on marine resources because no marine construction is required for the recommended tunnel alternative and all tunnel spoils will be used on Deer Island to construct landforms for visual and noise barriers.

- The pumping stations and vertical access shafts are not located in proximity to any historical or archaeological resources.

- There are no effects on current or future potential for recreational opportunities on either Deer Island or Nut Island.

- Impacts on terrestrial ecology will be minimal, considering the lack of any unique existing resources and the on-going construction activities in the affected areas.

Section 2

2.0 INTRODUCTION

2.1 PROJECT NEED

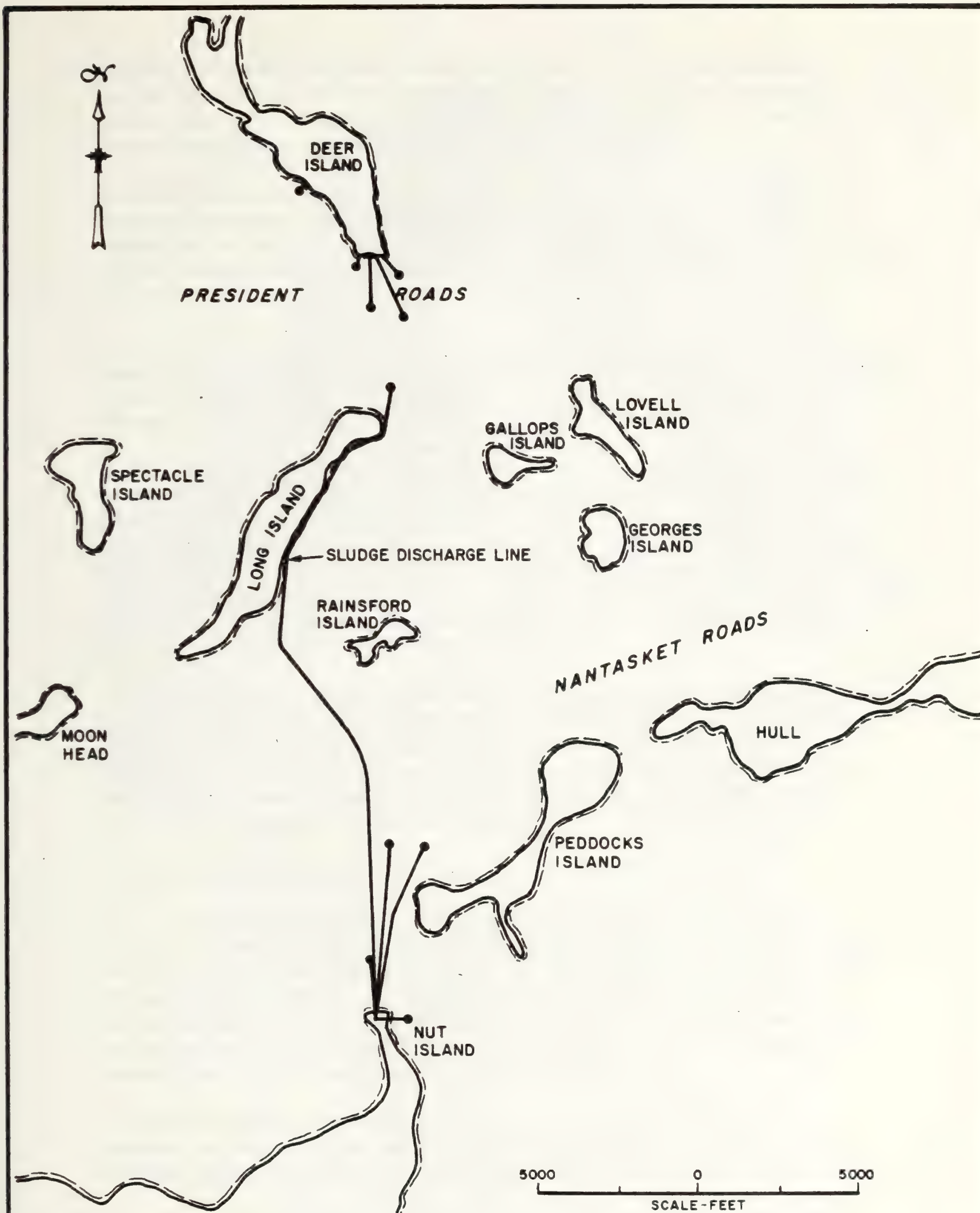
Since the time of the Revolutionary War, Boston Harbor has been considered a national landmark. The largest seaport in New England, it supports a variety of marine activities including shipping, fishing, boating and recreation. It encompasses an area of 47 square miles bordered by residences, commercial buildings, restaurants, marinas, beaches, industries and shellfishing flats. But since the settlement of Boston's shore areas, and most particularly since the City of Boston took possession of Deer Island for "sanitary purposes" in 1847, the Harbor has been the receiving water for all of the domestic, commercial and industrial wastewater and stormwater from the Boston metropolitan area.

Today, nearly 5,000 miles of sewers, conduits and pipes collect sewage from 1.9 million people and 43 metropolitan cities and towns and transport it to the area's two sewage treatment plants at Nut Island and Deer Island for treatment prior to discharge to Boston Harbor. Both of the plants are designed to provide primary treatment. Each plant provides disinfection of the primary effluent prior to discharge to the Harbor to reduce the levels of pathogenic bacteria. The disinfected effluent from Deer Island is discharged through two diffuser equipped outfalls into President Roads approximately 1,500-2,000 feet from Deer Island. Two additional relief outfalls are located 500-750 feet from Deer Island.

The disinfected effluent from Nut Island is discharged north through two main outfalls into Nantasket Roads approximately 4,500-5,000 feet from Nut Island. During periods of high flows and/or extremely high tides a third outfall extending about 1,500 feet north into West Gut side of Hingham Bay may be used. In addition, an emergency outfall extends 500 feet into the Hingham Bay side of West Gut.

The sludges removed from both plants are anaerobically digested and discharged into President Roads on the outgoing tide. Figure 2.1-1 illustrates the location of each of the treatment facilities and discharge locations. The combined discharge of primary effluent and sludge to the relatively shallow waters of Boston Harbor imposes a significant burden on the marine ecology in the waters surrounding the discharge. The discharge of floatable materials results in a significant deterioration in the aesthetic qualities of this vital resource. Because these discharges are but a few of the total discharges to Boston Harbor, and because scientific research to delineate the impacts of each discharge on the harbor has been limited to date, the precise impacts of the primary effluent and sludge are difficult to quantify. However, these discharges are unquestionably very sizable and the materials being discharged are ecologically significant. Thus, every reasonable effort should be made to reduce these discharges.

The Deer Island treatment facilities were constructed in 1968, and the Nut Island treatment facilities in 1952. Both facilities have exceeded their useful lives and the levels of treatment provided are often less than optimal because of the unavailability of replacement equipment. Nut Island has recently undergone a rehabilitation of most of its major components. A similar rehabilitation is now underway for Deer Island. Rehabilitation of the existing



MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 2.1-1 DEER ISLAND AND NUT ISLAND EFFLUENT AND SLUDGE DISCHARGE LOCATIONS

treatment facilities will optimize the levels of removal that these facilities can consistently provide. However, even the rehabilitated facilities cannot provide the levels of treatment desired. The design criteria and installed equipment of the existing primary facilities do not represent state-of-the art technology; therefore, they require replacement.

The 1972 Federal Clean Water Act requires that all municipal sewage treatment systems incorporate secondary treatment. Secondary treatment is more complex than the primary treatment that the flows at Nut Island and Deer Island currently receive, removing significantly higher levels of both organic materials and solids from wastewater (80 to 90 percent).

Like the Federal Water Pollution Control Act, the Massachusetts Clean Water Act requires promulgation of water quality standards for waters within the Commonwealth. The Massachusetts Division of Water Pollution Control has established these standards to satisfy the requirements of both acts. Thus, both Federal and State statutes require increased levels of treatment.

In 1982, the City of Quincy filed a suit against the Metropolitan District Commission (MWRA's predecessor agency) charging violations of laws prohibiting discharges into coastal waters and tidal waters, and violations of the common law of nuisance. As the suit progressed, the Massachusetts Water Resources Authority was created by the Massachusetts legislature. Almost simultaneously with MWRA's creation, the U.S. Environmental Protection Agency filed suit against MWRA alleging violations of the Clean Water Act. The Federal District Court found MWRA to be in violation and ordered the Authority to plan and construct new treatment facilities in accordance with an aggressive schedule (see Section 3.4.)

The need for upgraded and expanded treatment facilities to serve the Boston metropolitan area is clear: current discharges place a significant burden on one of the area's vital natural resources; the existing treatment facilities have long exceeded their useful lives; the existing treatment facilities do not reflect state-of-the-art technology and design; Federal and State statutes require enhanced levels of treatment; and the Federal Court has intervened and ordered an upgrading of the treatment facilities.

2.2 PLANNING APPROACH

This facilities planning study provides the foundation for the Massachusetts Water Resources Authority's program for the construction and operation of new primary and secondary wastewater treatment facilities at Deer Island. This planning has been approached with the understanding that the facilities planning effort must secure and sustain the acceptance and support of the diverse community, government and business interests that it affects. Therefore, the planning process was based not on technical strength alone, but also on the continual reconciliation of political, legal, environmental, economic and community interests.

A critical component of the facilities planning for secondary treatment facilities has been completed: the siting of the new treatment facilities. The decision-making process and the mitigation commitments made during that siting process are considered to be firm guidance for

the planning to be undertaken in this project. (See Section 3.2 for a description of the siting decision.)

The successful treatment of wastewaters from the Boston metropolitan area requires not only that enhanced treatment facilities be provided, but also that reliable, environmentally sound facilities be provided to manage the disposal of the residuals that are the direct by-products of wastewater treatment. The residuals management facilities plan is being conducted as a separate but concurrent study. The facilities needed and the sites being considered for residuals management are quite different from those needed for secondary treatment. However, the schedule for completion of the residuals management facilities plan is similar to the schedule for this plan. In addition, the approach and work plans for both of these planning studies recognize the synergistic relationship of these two plans. Thus, this planning study must be read with full cognizance of the residuals management facilities planning.

The facilities needed to provide secondary treatment include new primary and secondary treatment facilities located on Deer Island; a new conduit to convey the wastewaters from the existing Nut Island plant to Deer Island (inter-island conveyance facilities); and a new outfall to discharge the treated effluent into the ocean. In addition, a fourth component has been identified for the project: early site preparation. Early site preparation is defined as any construction activity that can start at an early date, i.e., before the completion of the on-island piers facilities needed to move the construction materials, equipment and personnel to the Deer Island site. The facilities planning for secondary treatment has thus been broken into four, stand-alone studies:

Treatment Plant, Volume III
Inter-Island Conveyance System, Volume IV
Effluent Outfall, Volume V
Early Site Preparation, Volume VI

To expedite the planning and review process, the facilities planning for secondary treatment has received a designation as a "major and complicated" project under the Massachusetts Environmental Policy Act regulations. The "major and complicated" project designation permits the environmental reviews to be concurrent with, and an integral part of, the facilities planning process. Thus, the documents being prepared to summarize the facilities planning are the same documents which will be used for environmental reviews.

The scope and sequencing of these facilities planning and environmental review activities are described in the following section.

2.3 SCOPE OF WORK

The purpose of the Secondary Treatment Facilities Plan is to evaluate the facilities needed to provide primary and secondary treatment, at a single facility to be located on Deer Island, of the wastewater conveyed through MWRA's North and South Systems. It will evaluate the facilities needed to convey the South System flows from the existing Nut Island plant to Deer

Island, as well as the outfall facilities needed to convey the effluent flows from Deer Island to a disposal point in marine waters. It will also identify and evaluate the construction activities which can occur as part of the Early Site Preparation effort prior to completion of the on-island piers and in preparation for the construction of the primary facilities.

The scope of work for the facilities plan is summarized below.

Project Management provides the overall project management required to ensure that the facilities plan is completed on time, within budget and with high standards of quality.

Data Collection inventories current and planned upgraded equipment and processes, assembles data regarding process equipment, mechanical, structural and hydraulic conditions, operating and maintenance characteristics, and expected useful life. Data Collection also will project flows and loadings, define the planning area, and provide a basis for evaluating further growth. This task will develop performance/removal criteria that will be used to balance the level of treatment required and the outfall location.

Facilities Engineering will characterize the wastewater to be treated, develop initial alternative planning and architectural concepts for Deer Island and ancillary facilities at Nut Island; complete site planning requirements; evaluate the adequacy of existing preliminary treatment facilities and evaluate unit processes for screening and grit removal; evaluate unit processes for primary treatment and residuals collection; evaluate unit processes for secondary treatment and residual collection; evaluate unit processes for disinfection; identify and evaluate the ability to control air emissions; establish alternative noise control methods and prepare a noise control plan for treatment plant operations and construction activities; determine the need for a pilot plant; evaluate the route and construction technology for locating and constructing the inter-island conveyance system and new effluent outfall; select an area for the outfall discharge which will meet water quality standards; characterize the soil and rock conditions under the proposed facility and related wastewater conveyance systems; identify and evaluate treatment processes; evaluate the reliability and flexibility of each of the treatment alternatives; estimate capital costs for the selected facilities and equipment; identify and estimate utility needs; identify operator needs and develop a preliminary operations plan; outline the requirements to operate the existing plants during construction; and provide pre-construction planning.

Institutional tasks include development of an annual cash flow projection required for the construction of the facilities; identification of the financial impacts of the recommended plan on MWRA's customers; identification of proposed changes or additional laws, regulations, legislative restrictions and agreements that may affect the implementation of the facilities plan; description of potential permit and regulatory agency approval requirements and preparation of a preliminary permitting plan; and implementation of a full-scale public participation program.

Recommended Plan is the preparation of the Secondary Treatment Facilities Plan and development of an implementation schedule/plan for each design and construction phase, as well as the

coordination of, and response to, reviews by regulatory agencies.

A more detailed outline of each work task will be found in Appendix A. Figure 2.3-1 illustrates the general flow of the planning activities.

SCHEDULE OF MAJOR DELIVERABLES

VOLUME	NAME	DRAFT REPORT	FINAL REPORT
I	EXECUTIVE SUMMARY	9/87	2/88
II	PLANNING BACKGROUND	6/87	12/87
III	WASTEWATER TREATMENT PLANT	9/87	2/88
IV	INTER-ISLAND CONVEYANCE SYSTEM	8/87,	12/87
V	EFFLUENT OUTFALL	11/87	3/88
VI	EARLY SITE PREPARATION	7/87	10/87
VII	INSTITUTIONAL CONSIDERATIONS	9/87	2/88

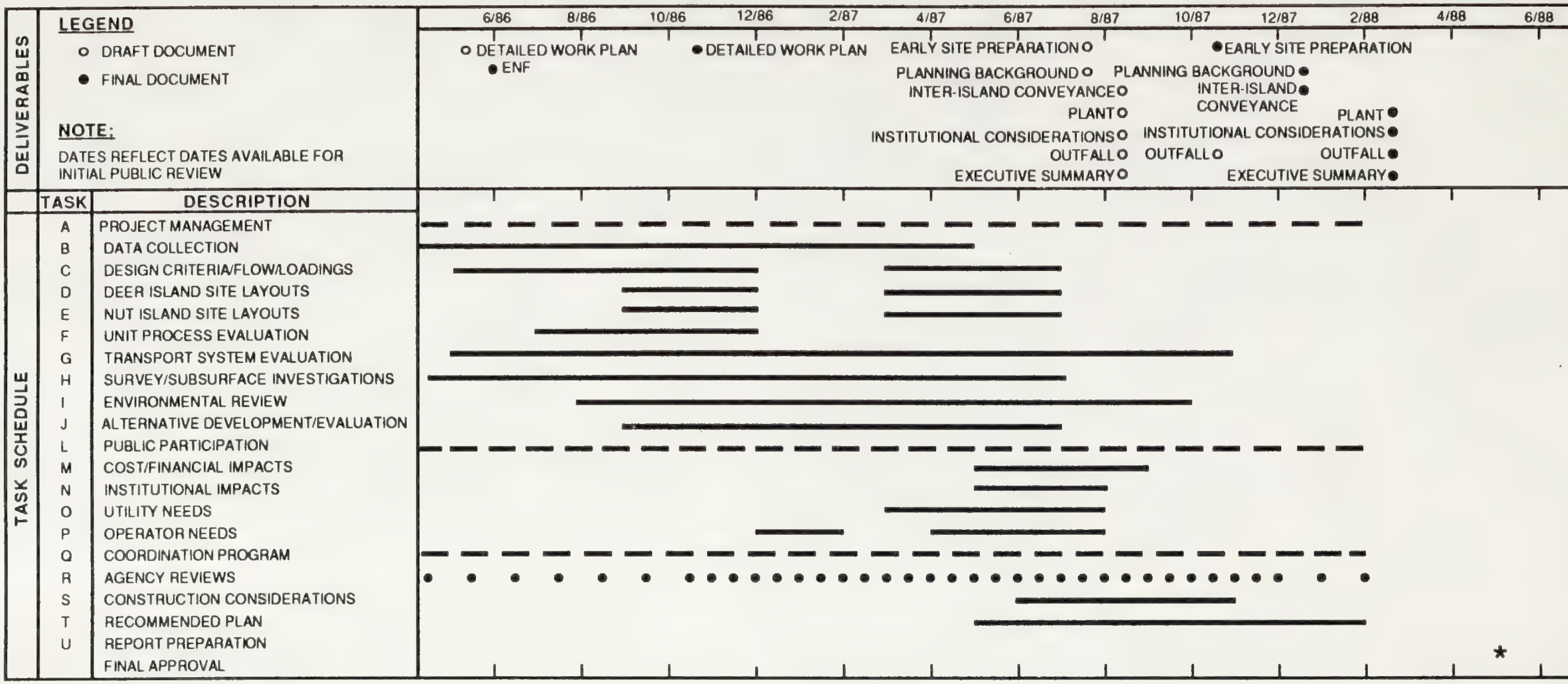


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FIGURE 2.3-1
SECONDARY TREATMENT FACILITIES
PROJECT PLANNING SCHEDULE

Section 3

3.0 PROJECT BACKGROUND

3.1 PREVIOUS STUDIES

Since 1900, there has been concern over water pollution problems in Boston Harbor. The State legislature initiated six investigations into the condition of the Harbor between 1900 and 1939. The last of these investigations resulted in the construction of the present Deer Island Treatment Plant which was completed in 1968.

But even as the Deer Island Plant was completed, the Federal Water Pollution Control Administration released a report on the impact of pollution on the Harbor's waters citing recreational, economic and biological impairment. The report generated increased interest in addressing pollution problems and at the first Enforcement Conference on Boston Harbor, state and federal officials agreed on the formation of a technical study group to explore measures for pollution abatement. The recommendations and agreements which grew out of these conferences, in conjunction with the mandates of the Federal Water Pollution Control Act and the Massachusetts Clean Water Act, have formed the framework for attacking pollution in Boston Harbor.

The process of identifying long-term wastewater treatment needs and solutions for the greater Boston Metropolitan area began in 1973 when the Metropolitan District Commission (MDC) began work on wastewater engineering and management planning for Boston Harbor. (See Table 3-1 for a list of planning reports for wastewater treatment in Boston Harbor). The Eastern Massachusetts Metropolitan Area Wastewater Management and Engineering Study (EMMA) was to ascertain what repair, replacement, extension, and expansion of facilities was required to provide adequate sewage treatment for the next fifty years.

In the fall of 1976, following publication of the EMMA Study, EPA's regional office requested that an Environmental Impact Statement (EIS) be prepared before any facilities planning. When the draft EIS was completed in 1978, it resolved the controversy regarding satellite facilities and proposed the consolidation of all planned treatment facilities on Deer Island.

A few months prior to the publication of the EIS, the MDC had responded to the 1977 amendments to the Clean Water Act which provided for a waiver of secondary treatment. If a waiver were granted, much of the construction contemplated in the EMMA Study would be deferred, at least until expiration of the modified permit, and perhaps indefinitely if the permit were renewed. Nevertheless, because regulations pertaining to the waiver process required that facilities plans to provide secondary treatment be prepared concurrent with the waiver process, the MDC, following release of the draft EIS, began preparation of a facilities plan.

Starting in 1983, the EPA and the Commonwealth jointly prepared the Supplemental Environmental Impact Statement/ Environmental Impact Report on the Site Options Study. The purpose of this document, which augmented the EIS evaluations done on the EMMA Study, was to review the environmental impacts of the Site Options Study alternatives, as well as other alternatives within the context of both the National and Massachusetts Environmental Policy Acts. The SEIS/DEIR started with twenty alternatives and selected seven treatment plant siting

alternatives for final review. The MWRA later reinstated one alternative for final review. Four alternatives involved secondary treatment and four involved primary treatment. The alternatives considered included locating all treatment at Deer Island, all treatment at Long Island, or combinations of plant locations that used Deer, Long and Nut Islands together in various configurations.

Also in 1983, almost five years after MDC filed a preliminary application for waiver of secondary treatment, the application was tentatively denied by EPA. Because of intervening regulatory developments, MDC was entitled to file an amended application. Shortly thereafter, MDC notified EPA of its intent to do so, and a scope of study was agreed upon, including water sampling to be performed in the summer of 1984. Final submissions were made by MDC in October, 1984.

Although the cost implications of secondary treatment and the ultimate rate-payer impacts promoted pursuit of the waiver application over several years, the waiver application exacerbated two major problems in planning the cleanup of Boston Harbor. First, as long as the "level" of treatment (secondary vs primary) was uncertain, the nature and size of new treatment facilities were impossible to fix for planning purposes. Second, planning for sludge management was frustrated because of the disparity in both the tonnage and character of sludge from secondary treatment as opposed to primary treatment.

On March 29, 1985, EPA rejected MDC's amended Section 301 (h) waiver application.

The Massachusetts Water Resources Authority assumed control of the MDC sewerage system on July 1, 1985. The MWRA made the decision to proceed as fast as possible with the secondary treatment program for Boston Harbor, notifying EPA that they would choose a preferred alternative for focused analysis by early July, 1985.

Table 3-1 is a listing of planning projects undertaken for Boston Harbor wastewater treatment since the 1976 EMMA study.

TABLE 3.1-1

SUMMARY OF PLANNING REPORTS FOR WASTEWATER TREATMENT IN BOSTON HARBOR

1976, March	Eastern Massachusetts Metropolitan Area Wastewater Engineering and Management Plan of Boston Harbor, Metcalf & Eddy, Inc.
1976	Non-structural Controls for Combined Sewer Overflows, Environmental Research and Technology, Inc.
1976, May	Joint Task Force Report on Major Manned MDC Facilities located in the Greater Boston Area, EPA Region 1
1976, July	Wastewater Management Planning: Boston Metropolitan Area Phase I Study, Urban Systems Research and Engineering, Inc.
1976, July	Phase I Engineering Report Boston Case Study, Kennedy Engineers, Inc.
1976, August	Phase I Final Report on Greater Boston Water Quality Issues in Planning for Pollution Control, Vertex Corp.
1976, November	Boston Metropolitan Area Waste Treatment Feasibility Study, Stone & Webster Engineering Corp.
1979, January	Wastewater Treatment Facilities Planning in the Boston Metropolitan Area - A Case Study, Kennedy Engineers, Inc.
1979, September	Application for Modification of Secondary Treatment Requirements for Discharge into Marine Waters of Boston Harbor and Massachusetts Bay for its Deer Island and Nut Island Wastewater Treatment Plants, MDC
1980, December	MDC Headworks Grit and Screenings Removal Systems - Preliminary Report, Whitman and Howard, Inc.
1982, June	The Commonwealth of Massachusetts Nut Island Wastewater Treatment Plant Facilities Planning Project, Phase I, Site Options Study, Volumes I and II, Metcalf & Eddy, Inc.
1982	Nut Island Wastewater Treatment Plant Immediate Upgrading, Metcalf & Eddy, Inc
1984	Deer Island Facilities Plan, Havens & Emerson/Parsons Brinkerhoff
1984	Supplemental Draft Environmental Impact Statement and Draft Environmental

	Impact Report, EPA
1984	Application for a Waiver of Secondary Treatment for the Nut Island and Deer Island Treatment Plants, Metcalf & Eddy, Inc.
1985, November	Final Environmental Impact Report on Siting of Wastewater Treatment Facilities for Boston Harbor, Camp Dresser & McKee, Inc.
1985, December	Final Environmental Impact Statement on Siting of Wastewater Treatment Facilities for Boston Harbor, EPA

3.2 SITING DECISION

The MWRA determined that the seriousness of the siting decision to be made and the newness of the MWRA as a participant in the decision process merited a thorough review of the material presented in the SDEIS/DEIR and comments made pursuant to that document, as well as a consideration of all additional information being developed in response to the issues raised by those comments.

The MWRA began its site selection process by reviewing the six criteria established in the SDEIS/DEIR (i.e., cost, effect on natural and cultural resources, effects on neighbors, harbor enhancement, implementability, and reliability). The MWRA voted to adopt these six criteria, but determined that two additional criteria should be adopted as well: equitable distribution of regional responsibility; and mitigation measures. The first of the new criteria, equitable distribution of regional responsibility, was viewed as subsuming the "fairness" issue which had been the subject of substantial commentary on the SDEIS/DEIR. The second new criterion, mitigation measures, was adopted to ensure consideration of both environmental and non-environmental mitigation and to permit the MWRA to fully respond to mitigation concerns during its siting deliberations.

The MWRA next reviewed the site options to be considered. It voted to examine the seven site alternatives proposed at the conclusion of the SDEIS/DEIR (all secondary Deer Island, split secondary Deer Island and Nut Island, all secondary Long Island, split secondary Deer Island and Long Island, all primary Deer Island, split primary Deer Island and Nut Island, split primary Deer Island and Long Island) and, in response to the Secretary's Certificate of Adequacy on the SDEIS/DEIR, also voted to reinstate for evaluation one site option that had been dropped from consideration at the close of the SDEIS/DEIR (all primary Long Island).

The MWRA then proceeded to an evaluation of each site alternative in the context of the criteria selected. A number of consultants were engaged to assist in the collection, evaluation and presentation of pertinent materials to the Board members at their publicly held meetings. Oral and visual presentations on each of the eight criteria were given, followed by questions and discussions which refined the issues to be addressed and identified further information to be obtained. Second presentations and discussions were held on seven of the criteria, and a third round of review and debate occurred on the criterion of cost. As a consequence of these deliberations, further presentations and discussions were held on several sub-topics that were of particular interest or thought to require additional attention.

In addition to its own consultants' presentations, the MWRA heard and discussed presentations by the Regional Administrator of EPA, by representatives of the Executive Office of Environmental Affairs and the Department of Environmental Quality Engineering, and by the technical and legal representatives of the Town of Winthrop and the City of Quincy. In all, the MWRA listened to and discussed at some length, 23 separate presentations on 13 different topics applicable to the preferred alternative siting decision.

A summary of all the siting presentations given and the Board's discussions was provided to the Board members for further review and analysis prior to the vote on the tentative preferred

alternative site selection. Copies of letters from officials and the public concerning the siting decision were either provided to Board members during the ongoing deliberations or were included in the siting summary notebook. The Board members also visited the sites being considered.

The following sub-sections contain summaries of the MWRA's deliberations concerning each criterion as it applied to the site selection to be made. Throughout the process of selecting the tentative preferred alternative site, the MWRA evaluated and compared the information received in light of the criteria adopted. It observed interrelationships among the criteria and discussed the value to be accorded to the criteria in the context of various site alternatives. The last sub-section summarizes the way in which the criteria weighed one against the other with respect to the sites considered.

Effect on Neighbors

The purpose of this criterion was to address treatment facility impacts on the neighbors of the treatment plant. Factors evaluated by the MWRA were traffic, noise, odor, visual effects, property values, and health and safety issues. An exploration of the numbers of persons potentially impacted by the proposed primary, secondary and split treatment plant site options was conducted. Distinctions were made between those who might be voluntarily exposed to the negative impacts and those who resided nearby and had no choice with respect to being impacted, with greater value being accorded to the latter. Consideration was also given to the potential impact of the treatment plant on those working, living or staying at either the hospital on Long Island or the prison on Deer Island. Weight was attached to the fact that persons in the institutions would be closer to the source of impacts for longer continuous periods and would be exposed to a higher degree of impact at any given time. Concern about the effects on these populations served in part to motivate the MWRA to analyze in more detail the "footprints" that could be accommodated on Long Island and on Deer Island and the need for and feasibility of mitigative design concepts, buffers, and/or the relocation of the respective institutions. Also considered was the exposure to impacts over a longer period of time as would be the case for most of the residential neighbors.

Traffic. Traffic access roads were reviewed for capacity and for anticipated peak and average use with and without the utilization of barging and busing. The MWRA learned that the greatest numbers of persons would be affected along the Winthrop access routes, but that a substantial number of persons would be affected along the East Squantum access routes as well. The fewest persons would be affected if the Quincy Shore Drive route to Long Island was available, but there were questions of implementability and structural feasibility that would have to be resolved in order to use that route. The degree of negative impact on the various roads was considered to be roughly the same for the various site alternatives.

A great deal of consideration was given to barging, with the recognition that it was required in order to sufficiently mitigate the traffic impacts that would be caused during construction. Implementability issues with regard to barging -- such as Coast Guard regulations and the construction of piers -- were explored, as were the costs of barging. A determination was made that the same requirements for barging applied to whichever site alternative was selected, and

therefore the concerns surrounding barging as a mitigation measure for the alleviation of traffic impacts on neighbors were found to be not site-determinative.

Also reviewed were the potential mitigation measures of ferrying workers to decrease traffic, and rehabilitating or replacing access bridges to accommodate heavy trucking. Implementing each of these measures appeared to pose a relatively similar degree of difficulty between sites and was not found to be an absolute deterrent. The cost of bridge repair or construction did differ between sites and was explored in greater detail by the MWRA in its concern for the issue of traffic impacts and the need to alleviate them. It was determined that it would be most costly to repair, replace or construct new bridges for access to Long Island.

Assuming a heavy reliance upon barging and taking into account the above factors, the MWRA concluded that the traffic impacts were significant but manageable with respect to all sites, and that this was not a site-determinative factor.

Noise. The information on noise contained in the SDEIS/DEIR was reviewed, and the concerns of the Town of Winthrop with respect to the adequacy of that information and the possible site-determinative nature of construction noise impacts were explored. Berms and temporary noise barriers were also discussed. The MWRA received a detailed letter from, and heard a presentation by, Winthrop's technical consultant. It further pursued additional noise information through the technical advisory group meetings and shared the ongoing work done by EPA's technical consultant. An update of this work was presented to MWRA by EPA shortly before MWRA's siting decision. The information on noise gathered and presented by EPA and adopted by MWRA for its tentative preferred alternative site selection indicated that although noise levels at Deer Island would result in greater impact to neighbors, particularly the close neighbors at the House of Correction, the level of construction noise at either site was at acceptable levels or could be sufficiently mitigated so that it was not a site-determinative issue.

Odor. The impact of odors, taking into consideration source, distance, population density, and potential for occurrence, was also evaluated. In addition to evaluating the effect of odors on nearby residences and the existing institutions, the MWRA considered the effect of odors on potential recreational users. It was determined that there might be intermittent effects on neighbors at either site with a potentially substantial effect on recreators at Long Island Head, given the seasonal wind patterns and projected siting plans.

The use of covered tanks to mitigate odors was explored. The MWRA balanced the mitigating effect of covered tanks against the operation and management difficulties that had been experienced at other plants utilizing covers and also considered the additional cost required to employ covered tanks.

After reviewing odors and their potential impact on any of the sites considered, the MWRA determined that odor control was a paramount concern in the design of the treatment plant and that stringent odor controls would be utilized no matter where the treatment plant was located. Having decided this, and having reviewed the odor impact information, the MWRA concluded that odor and its control posed somewhat different problems at each island but balanced out

sufficiently so as not to be a site-determinative issue between Long Island and Deer Island.

Odor impacts were found to have some significance, however, in the choice between all secondary options that retained the existing institutions and those secondary options featuring removal of the hospital or House of Correction. The options featuring retention of the existing institutions were considered less desirable because the ability to design the treatment plant with odor sources farther away from residential or recreational uses was substantially reduced at the more constrained sites. The retention of the institutions also increased the number of persons impacted and degree of severity of impact with respect to the persons living, working or staying in the institutions.

Visual Effects. It was determined that a treatment plant on either island would have a negative impact on persons in the existing institutions due to proximity. With respect to residential neighbors, it was determined that if the institutions remained, there would be a greater negative impact from a treatment plant on Deer Island. If the House of Correction were removed, however, modifying landforms and landscaping could be used to screen the treatment plant from most residences.

Property Values. The effect on property values of the construction and operation of the treatment plant was addressed. Comparisons of affected communities with respect to fair market value, past appreciation, turnover rates and anticipated changes due to treatment plant construction and operation were reviewed. It was generally concluded that, no matter which site option was selected, property values probably would not decline during successful plant operation. However, there was discussion that there may be a decline of property values for communities near the treatment plant during construction but that these values would likely rebound fully after completion of construction. Also discussed was a projected possibility that property values around Deer Island might not fully rebound after construction. However, it was also deemed possible that the substitution of a carefully constructed and well-run treatment plant on Deer Island might raise values in the neighboring communities higher than they would be with the continuation of the existing plant operation. On the whole, property value impacts were determined not to be site-determinative, but a matter to be addressed through mitigation once a site was selected.

Health and Safety. Health and safety concerns of the community -- such as traffic impacts on schools and the elderly, chlorine delivery, air quality reduction from traffic or the facility operation -- were examined and not found to be site-determinative factors.

Summary of Effects on Neighbors. Most of the effects considered within each of the above sub-categories of effects on neighbors were found to be roughly equivalent when applied to the various site options. Although there were perceived imbalances of effects under some of the sub-categories, imbalances against one site under one sub-category tended to be neutralized by imbalances against another site in another sub-category. For example, imbalances found against the use of Long Island for either all secondary or mixed alternatives due to the additional cost of the traffic mitigation measures of repairing or replacing access bridges tended to balance out against the additional cost that might be required for noise mitigation on Deer Island, particularly if the House of Correction was not removed.

Similarly, the imbalance against Long Island caused by the determination that more substantial odor effect was likely on potential recreators was balanced against the possibility for greater negative visual impacts on residential neighbors from a treatment plant on Deer Island if the House of Correction was not removed. In sum, when all the effects were weighed within the sub-categories and the total effects of each sub-category were weighed one against the other, the MWRA concluded that the criterion of effects on neighbors, as a whole, was not site-determinative.

Equitable Distribution of Regional Impacts

Equitable distribution of regional impacts was adopted by the MWRA as an additional criterion in response to the issues of fairness raised in the comments on the SDEIS/DEIR. The criterion brought into the decision process considerations of how many and what kind of impacts a community might already bear from proximity to regional facilities other than the contemplated treatment plant. For example, impacts on Winthrop from Logan Airport, the Deer Island House of Correction and the current Deer Island treatment plant were reviewed, as were the effects on Quincy of the existing Nut Island treatment plant and flight patterns from Logan Airport. Distinctions were made between regional uses that provide little benefit to the community impacted (such as Logan Airport vis-a-vis Winthrop) and those regional facilities which daily serve a number of residents of the impacted communities (such as MBTA stations in Quincy). It was further noted that the impact from the latter use was mitigated by the existence of a local-aid fund which provides some monetary reimbursement to host communities.

The consideration of regional use burdens on potentially impacted communities had two applications in the preferred alternative siting decision. First, there was an assessment of whether or not the cumulative regional burdens on any one particular community would be so excessive if the treatment plant were sited nearby as to require, without regard to any other criteria, that the treatment plant be sited elsewhere. One decision-maker concluded that the cumulative and long-term burdens imposed on Winthrop currently and in the past required a decision to site the treatment plant at a location other than Deer Island. Other decision-makers decided that the degree of unfairness did not rise to the level of unilaterally precluding the siting of the treatment plant on Deer Island.

The second way in which the criterion of equitable distribution of regional impacts was applied was to broaden the scope of factors to be considered in assessing effects on neighbors and in determining the nature and degree of mitigation measures to be undertaken. As to the former, the impacts of other regional uses were evaluated not only separately, for their effect on the community, but as they might combine with the noise, odor, and other impacts of the proposed treatment plant.

In assessing the impact of regional facilities on the various communities, the MWRA concluded that the choice of any of the alternative site options was unfair to whichever of the communities were impacted, by virtue of the burdens to be borne by those particular communities on behalf of so many other communities. When contrasting the relative regional burdens between the impacted communities, some decision makers noted that the greatest share of burdens for regional impacts was already borne by the City of Boston and that Boston's burdens would be

increased whichever option was chosen. Between the City of Quincy and the Town of Winthrop, the MWRA concluded that the greater number of regional burdens borne by Winthrop made it more unfair to Winthrop to locate the plant on Deer Island than it was unfair to Quincy to locate the treatment plant on Long Island.

Cost

From the outset of its deliberations, the MWRA considered cost to be an important criterion. One of the first tasks the MWRA undertook was to closely examine the previous cost estimates which had been included in the 1982 MDC Site Option Study and the SDEIS/DEIR. Those cost estimates and a new set of estimates prepared by MWRA's consultant were analyzed and discussed both as to the absolute dollar figures presented and as to the relative differences in costs between sites.

Following the initial presentation to and discussion of these figures by the MWRA, consensus was reached by the various cost estimators which reduced the range of difference among them by half. The MWRA reviewed the original figures, the new figures, the basis for each and the rationale for the differences. It recognized that the figures could be firm to only a certain degree, given that a site was being selected prior to any facility design being undertaken. The MWRA chose to consider the higher figures in the range as better representing the most conservative case for design and construction needs and choices, including but not limited to greater assurances of reliability through increased redundancy and mechanical backup.

At each stage of development of the cost figures, the MWRA determined whether the differences changed the ranking or rating of the site alternatives or the relative differences between the alternatives appearing in the SDEIS/DEIR. As to the first two stages of development in cost estimates described above, the MWRA concluded that the ranking or rating of alternatives remained the same and the relative difference between the sites remained constant no matter which estimates at which level of refinement were used.

However, as the deliberations of the MWRA with respect to the other criteria continued, it became evident that cost was closely intertwined with assessments of those criteria and constituted an important factor for each item evaluated. As a result, further discussion and inquiry on costs were undertaken by the MWRA, and a third and more detailed cost analysis was produced. The resulting figures were reviewed and discussed by the MWRA. It was determined that while the new figures narrowed the difference in cost between some of the options involving Long Island and some of the options involving Deer Island, it did not change the ranking of any of the site alternatives.

The MWRA also developed and discussed a comparison of costs between Deer Island and Long Island with and without the existing institutions. The MWRA concluded that in all cases, it was less costly to construct the treatment plant on Deer Island as compared to constructing it on Long Island. It further determined that it was less costly to construct the treatment plant on either of the islands without the respective existing institutions being present.

Implementability

The MWRA utilized the implementability criterion to assess how quickly and how predictably the treatment plant could be completed at each of the alternative sites. This included a review of the requirements for and potential impediments to obtaining the real estate necessary for the construction of the treatment plant under the various alternatives. After examining the ownership and the means by which that ownership could be transferred, the MWRA concluded that obtaining the required land under all the options was roughly equal in terms of the legal steps to be taken and the likelihood of success.

The MWRA also reviewed the various permits, licenses and approvals that would be required from federal, state and local authorities in order to build the treatment plant under the various site plans proposed. It found that most of the state and federal permits required were equally applicable to Deer Island and to Long Island. It noted that burial grounds and archaeological/historical properties were a significant issue with respect to Long Island and would probably require extensive mitigation efforts, but also took into account that Deer Island had historic resources that might require consultation with authorities and possible mitigation. Similarly, the MWRA examined the conclusion of the SDEIS/DEIR that the permit issues surrounding burial grounds principally impacted Long Island, but also noted the possibility that they might be involved with Deer Island as well. With regard to the loss of historical or archaeological resources, the MWRA gave weight to the fact that the necessary consultation, mitigation and approval process for whichever island was selected could be engaged in concurrently with the facility planning and design process for the treatment plant, and would not greatly delay the construction of the facility. It was also considered important that this approval process, while requiring consultation and mitigation, could not prohibit the construction of a treatment plant on either island.

Further implementability issues that might apply to only one of the islands, or might be more difficult on one island as compared to the other, were examined. These included wetlands, order of Conditions, bridge construction, barrier beaches, opening of Shirley Gut, air quality questions, possibility of contaminated dredge spoils, existing grit and screenings, hospital relocation and House of Correction relocation. The first three of these issues were thought to have more certain application to Long Island but were considered to have possible application to Deer Island as well. The middle three issues were looked at as possibly raising additional or more difficult issues in the case of Deer Island. Air quality issues were discussed with EPA, and further information obtained by the EPA indicated to the MWRA that the treatment plant could be located at either island without violating national ambient air quality standards for air pollution under the configurations being considered by MWRA and by EPA.

Implementability of relocating the existing institutions on Deer Island and Long Island was scrutinized very closely by the MWRA. The MWRA heard and considered presentations by legal counsel to the City of Quincy and the Town of Winthrop on the need for and comparative legal difficulty of relocating the institutions. The MWRA also received and evaluated communications from the Governor of the Commonwealth, the Mayor of the City of Boston and the Speaker of the Massachusetts House of Representatives. The MWRA concluded that, as to real estate and permit approval issues, the various site options balanced out with respect to implementability. The

removal of the House of Correction from Deer Island, however, was felt by the MWRA to be more feasible than removal of the Long Island Hospital, considering the commitments made by the authorities who would be in a position to implement the respective relocations.

Reliability

The MWRA viewed reliability as the concept of enhancing the overall integrity of the waste treatment system. Information was received on such factors as minimization of detrimental consequences of outages, operational capabilities during and after construction, managerial enhancement and technological reliability. Particular issues of reliability were explored in more detail. The performance of a secondary treatment system was reviewed at some length with stress on the need for proper design to handle such things as variable loads and intake of septage to prevent a malfunctioning of the system which would result in partially treated sewage being released into the harbor through a short outfall. The reliability of tunnels was reviewed, and the use of round versus rectangular clarifiers was discussed. Also considered was the need for backup in the case of catastrophic outages.

With regard to clarifiers, the Board heard that circular clarifiers were considered more reliable by some and that use of those clarifiers would require a greater acreage and expenditure to install, but it also heard that a comparable degree of reliability could be provided by rectangular clarifiers, which use less space and are less costly. The MWRA determined that either type of clarifier could be utilized under the various site options being considered.

The greater or lesser use of tunnels under any particular site option was considered to be an insignificant factor since it was determined that reliability of tunnels could be assured through proper design and maintenance during construction and operation. There was a recognition that those site options with split plants would provide greater reliability in the case of catastrophic outages, but this fact was determined to be offset by the consideration that such outages could be expected to occur at very infrequent intervals and that the ability to achieve reliability at split plants would be more costly because of the need to provide two sets of administration and staffing.

In assessing the various site options in light of reliability factors, the MWRA concluded that, while reliability was a very important consideration in constructing and operating the wastewater treatment plant, it was not a determinative factor in selecting site options between Long Island and Deer Island. Reliability was viewed by the MWRA, however, as a very important factor in its relationship to impact on neighbors. Any reduction of efficiency or increase in operational malfunctions would potentially create greater negative impacts, such as odors, on the neighborhood. It was also recognized and considered an important factor that the capital cost of the secondary treatment plant would be greatly increased by the design and engineering which would be necessary to protect against the greater unreliability inherent in a constrained site. Also, higher operational and maintenance costs would have to be anticipated as a result of the more complex design that would be required.

Weighing all these factors, the MWRA concluded that greater reliability would be obtained in

any of the secondary treatment plant options if the respective existing institutions were removed and, conversely, that reliability would be severely impacted if the secondary treatment plant was built without removing the respective institutions. In any other regard, reliability was considered to be equally obtainable at all site alternatives considered and therefore not site-determinative.

Harbor Enhancement

The MWRA's view of harbor enhancement incorporated compatibility of the proposed treatment plant with attainment of the harbor's potential. The MWRA reviewed the site alternatives not only with respect to how each site option might serve as a source of impact on the harbor but also as to how each option might serve as an opportunity for achieving the objectives listed. This information for the site options -- as they related to one another and to the harbor as a whole -- was then considered.

Certain concerns of the MWRA were further explored. The potential for recreational use of Deer Island was reevaluated and discussed. As a result, the MWRA accorded greater weight to the recreational potential of Deer Island than had been previously assigned to it in the SDEIS/DEIR. The MWRA concluded that the recreational potential of Deer Island and of Long Island, absent any development, was similar in a number of ways with many of the same types of activities potentially available. Two differences were found to favor the preservation of Long Island's recreational potential, however. The first was the greater potential for public swimming beaches at Long Island. The second was the wilderness experience derived from the wild vegetation in the undeveloped parts of Long Island which, once destroyed, could not be recreated elsewhere.

The two islands were also reviewed for compatibility of recreational use with a treatment plant present. If the existing hospital were retained along with the treatment plant, Long Island would lose the significant recreational potential of Long Island head but might retain its barrier beaches, whereas if the existing House of Correction were retained, Deer Island might be able to encompass a small naturalized park located at Deer Island head. If neither existing institution remained along with the treatment plant, a park at Long Island head and an environmental study area in the southwest of long island could possibly be preserved, while at deer island, a neighborhood park and a regional park could be created and the natural beaches preserved.

It appeared to the MWRA that the quality of recreation on the islands -- co-existent with a treatment plant but without the existing institutions -- was higher for Deer Island than Long Island. At Deer Island, existing or man-made landforms could screen recreational areas from nearby receptors. At Long Island, the treatment plant would be highly visible, and the wind patterns might carry the odors over Long Island Head a significant amount of the time. In balance, the MWRA felt that greater recreational potential for the harbor would be available by building the treatment plant on Deer Island rather than Long Island with or without the existing institutions, but particularly in the latter case.

The MWRA also considered implementability of recreational plans. It was noted that Long Island

was physically ready to be developed for recreational use almost immediately if no treatment plant were sited there, but that a much longer time would elapse if recreational use had to wait until a treatment plant was operational on Long Island and the Deer Island treatment plant subsequently removed. The availability of funds for recreational development of Long Island as an already established priority in the Boston Harbor Islands Park system enhanced the likelihood of recreational development of Long Island in the near future.

In assessing the visual effect of the various treatment plant site options, it was determined that the primary and secondary treatment plant options at Long Island were deemed to produce the most radical changes to the natural terrain and to impact the most negatively on the harbor as a whole.

Having reached the above conclusions and having evaluated the information contained in the SDEIS/DEIR, the MWRA concluded that harbor enhancement would be promoted by the preservation of Long Island as a potential park resource and, conversely, that the harbor would be diminished both visually and for recreational purposes, if the treatment plant were constructed on Long Island.

Effect on Natural and Cultural Resources

The MWRA examined the natural and cultural resources that would be impacted by each of the site option alternatives. In addition to the information contained in the SDEIS/DEIR, summaries further distilling the information and updated reports of ongoing evaluations of the sites by the Massachusetts Historical Commission were heard and evaluated. The MWRA not only considered the number and significance of historical, cultural and archaeological structures and sites, but also the degree of mitigation that might be required if such places and things were disturbed. The possible effect of any mitigation measures on duration and cost of construction was then assessed. The MWRA also gave some weight to the nomination or intended nomination of those items to the National Register of Historic Places.

The MWRA took into account the number of archaeological sites in existence, the rarity and integrity of such sites, the contribution of such sites to an understanding of our history, and the quantity of material contained in the sites. It was noted that no archaeological sites had been uncovered at Deer Island, but the MWRA also took into account that there had not been as thorough a survey of parts of Deer Island as there had been for the whole of Long Island. Nevertheless, in reviewing the five prehistoric sites uncovered at Long Island, the MWRA determined that their preservation deserved stronger consideration in the choice of a site.

With regard to cemeteries, the MWRA contrasted the existence of several cemeteries on Long Island with the possible existence of a cemetery on Deer Island. Again, however, it noted that Deer Island had not been as intensively surveyed as Long Island. It noted that Long Island in its entirety was being considered for nomination as part of the Boston Harbor Archaeological District. The MWRA concluded that the existence of cemeteries was not as significant as the existence of archaeological sites since the cemeteries could be moved and preserved elsewhere. Although the movement of graves raised implementation issues, those issues were the same for each island and were not considered to be impossible to overcome.

The MWRA also reviewed the potential eligibility of the Long Island Hospital, the Deer Island House of Correction, and the Deer Island pumping station for listing on the National Register of Historic Places.

Lastly, the MWRA reviewed the natural resources of the two islands. While little or no adverse impacts to the natural resources on Deer Island were found, with the exception of the removal of the drumlin on Deer Island in the case of a secondary treatment plant being sited there, it was determined that the wetlands and barrier beach at Long Island might be adversely affected by the construction of either a primary or secondary treatment plant even if strict controls were imposed. Concern was expressed that even a split secondary option would impact on sensitive areas on Long Island. In sum, the MWRA concluded that the least negative impact on natural resources would be achieved by selecting Deer Island for an all-secondary or all-primary wastewater treatment plant.

Mitigation Measures

The MWRA used the criterion of mitigation measures to focus on and clearly consider those actions which might be or ought to be taken with regard to a particular site to make that siting choice environmentally acceptable, and to assure to the greatest extent feasible that negative impacts from the siting selection would be alleviated or compensated for. The MWRA considered both environmental and non-environmental measures.

Environmental Mitigation. Environmental mitigation measures were considered to be those steps which would minimize adverse impacts from the construction and operation of the treatment plant.

Construction impact mitigation measures reviewed included barging, land modifications and buffers, scheduling and specifications for equipment to reduce noise impact, and monitoring and response mechanisms to oversee and enforce construction mitigation efforts.

Operations impact mitigation measures examined included the use of technology, design and buffers to reduce noise, odors and visual impacts on residences, institutions and/or recreators, as well as adaptation of site layouts and monitoring mechanisms to ensure proper operation and maintenance of the treatment plant and to assure responsiveness to changing conditions.

Most of the environmental mitigation measures were explored not only separately but as part of discussions involving reliability, effect on neighbors, cost, site layouts and effect on natural and cultural resources and are addressed to varying degrees under each of those topics in the FEIR. The MWRA articulated throughout these discussions a strong commitment to environmental mitigation, particularly as it would reduce negative impacts on the nearby receptors. It also recognized, however, that the extent of the mitigation employed would be determined, in part, by balancing the cost to the ratepayers against the degree of mitigation to be achieved. In some cases a determination was made that certain amounts or kinds of mitigation would be undertaken regardless of cost. For example, it was decided that stringent odor controls would be employed no matter where the treatment plant was constructed. It was

also determined that a significant degree of barging was required for the transportation of construction equipment and materials.

Most of the environmental impact measures considered were deemed applicable in some degree to all sites, but some measures were found to be required more frequently or to a greater degree under one site option or another. For example, the environmental mitigation measures to be employed when disturbing cultural or natural resources were perceived to be required more often and to entail more effort at Long Island than at Deer Island due to the greater number and value of sites located at Long Island. Balanced against this was the greater impact of noise on Deer Island neighbors and the resulting need for additional mitigative measures. The MWRA concluded that the individual environmental mitigation measures or the degree to which those measures might need to be applied differed from site option to site option but that, when all the mitigation measures for a particular site were totaled and balanced against all the mitigation measures required for another site selection, the environmental mitigation measures tended with one exception to balance out and not to be site-determinative. The exception pertained to the split plant options which would require the implementation of mitigation measures at two sites instead of one, with a substantial increase in cost. The MWRA considered this a factor to be weighed against selection of the split plant options.

The MWRA did decide that mitigation measures, while not being site-determinative between all Deer Island and all Long Island, were of critical importance with respect to whichever site it chose. Consequently, MWRA voted just prior to selecting its tentative preferred alternative site, that its FEIR for siting the Harbor Islands treatment plant should include a complete discussion of all practicable means and measures to minimize damage to the environment in connection with construction of the new sewage treatment facility including but not limited to (i) barging of construction material and personnel, (ii) limitations on unnecessary construction period traffic, (iii) controls on construction noise, (iv) controls on operating noise and odors, (v) visual enhancements of the site, (vi) alternatives to through-neighborhood trucking of chlorine for purposes of facility operations, (vii) construction of deep ocean outfalls, and (viii) development of compatible recreational uses on the site and elsewhere in Boston Harbor. The Board also voted on the day it made its tentative preferred alternative selection that it preferred that sludge management facilities be located off-site from the treatment facility.

Non-Environmental Mitigation. The MWRA considered non-environmental mitigation to be an important consideration in the siting decision and a necessary adjunct to the construction of a treatment plant of the size and complexity planned. Non-environmental mitigation measures examined were the opening of Shirley Gut, which would physically isolate Deer Island from the mainland, rehabilitating or reconstructing access bridges, development of recreational or other multi-use possibilities for the sites considered, protection against future facility overload, assurances of plant operating performance, employment of innovative technology, and relocation of the existing institutions. With respect to the measures reviewed, the ones determined to be site-specific were those concerning access bridges, opening of Shirley Gut, and relocation of the existing institutions.

As discussed in the text regarding the criterion of effect on neighbors, the MWRA evaluated the

comparative difficulty and cost regarding rehabilitation or replacement of access bridges and determined that it would be more costly to repair, replace or construct new bridges for access to Long Island.

After examination of the geologic processes and currents affecting Shirley Gut, the need for and high cost of maintenance to keep the Gut cleared, the numbers of regulatory requirements for undertaking such a project and the possibility that its being opened would result in greater nearshore pollution and perhaps permit movement of polluted waters from Boston Harbor through the gut to the eastern shores of Point Shirley and Winthrop, the MWRA determined that the opening of Shirley Gut was not a feasible mitigation measure and that other means of separating Deer Island from the mainland should be considered if a need for separation were determined necessary or desirable.

The relocation of the existing institutions was determined by the MWRA to be a critical non-environmental mitigation measure. This conclusion resulted from the MWRA's evaluation of: the effects of noise, odor and visual aspects of the treatment plant on the persons working in or inhabiting the institutions; the reduction in reliability which would result from construction of the treatment plant on sites constrained by the presence of the institutions; the far greater construction cost and ongoing maintenance and operational costs which would result from having to construct the treatment plant on a constrained site; and the greater recreational potential which would be available for the harbor if the institutions were removed. With respect to cost, recreational potential and the effects of noise, the MWRA concluded that it was even more important to relocate the House of Correction than the Long Island hospital, since the negative impact from retaining the existing institution on the same site as the treatment plant was greater for Deer Island than for Long Island. The MWRA also determined that while regional impacts would be more equitably distributed by the relocation of either institution, more equitable distribution would result from the relocation of the House of Correction due to the nature of the respective institutions and the number and kinds of regional impacts already experienced by the Town of Winthrop. The MWRA further noted that property values were more likely to be increased in the Town of Winthrop by the removal of the House of Correction than those in the City of Quincy by the removal of the hospital, and that the health and safety of residents of the Town of Winthrop were apt to benefit by the relocation of the House of Correction.

In sum, the MWRA concluded that if either Long Island or Deer Island were selected, the existing institutions should be relocated. As between the two islands, the MWRA decided that it was more important and more beneficial to remove the House of Correction if Deer Island were selected than it was to relocate the hospital if Long Island were selected. Some decision makers felt that if Deer Island were selected, the House of Correction must be relocated. For these decision makers, the relocation of the House of Correction was not a mitigation matter but an action compelled by the other criteria.

In evaluating the removal of the institutions, the MWRA placed strong emphasis on the implementability of such a measure. It received and considered commitments made by those authorities empowered to and responsible for any such relocation and determined that the implementability of relocating Deer Island House of Correction was extremely likely -- far more

likely than relocating the hospital.

As with environmental mitigation, the MWRA indicated its strong commitment to non-environmental mitigation by voting for the preparation of a complete discussion, for use by the Board of Directors, of proposed non-environmental mitigation measures for the construction of the Harbor Islands treatment plant including, but not limited to, construction workforce hiring preferences for residents of impacted communities, protection against diminished real estate values from nearby construction activities, preferential economic considerations for impacted communities, and funding for repair of bridges, roads or other physical infrastructure damaged by construction activities.

Criteria Weighing Process

The MWRA concluded that while all the criteria were important, some criteria were of relative equivalent value when applied to the various site options and were not site-determinative. Those criteria were: reliability, effects on neighbors, and implementability, as well as the environmental mitigation part of mitigation measures.

The five criteria which the MWRA concluded were site-determinative were: cost, equitable distribution of regional impacts, harbor enhancement, effect on natural and cultural resources, and non-environmental mitigation. All the site-determinative criteria except equitable distribution of regional impacts weighed in favor of selecting Deer Island as the site for the wastewater treatment plant. While the considerations of fairness implicit in the equitable distribution of regional impacts were valued very highly by the MWRA, they were not sufficient, by themselves, to outweigh the considerations of cost, harbor enhancement, effect on natural and cultural resources, and non-environmental mitigation measures.

In addition to determining which island should be the site for the construction of the Harbor Islands wastewater treatment plant, the MWRA concluded that whichever island was chosen, any existing institutions on that island should be removed. It based that conclusion on the results of applying the criteria of reliability, cost, harbor enhancement, effects on neighbors, and mitigation measures. Furthermore, the MWRA found on the basis of cost, equitable distribution of regional impacts, effects on neighbors (health and safety)*, harbor enhancement, implementability, and mitigation measures (non-environmental) that Deer Island without the House of Correction was the best site configuration considered. For some decision-makers, these latter criteria compelled the conclusion that if Deer Island were to be chosen as the site for the treatment plant, the House of Correction had to be removed.

* While health and safety issues originating from the construction and operation of a wastewater treatment plant were found not to be site-determinative, health and safety were considered to be enhanced by the removal of the House of Correction.

Tentative Selection

On July 9, 1985, on the day prior to its selection of a preferred alternative site, the MWRA voted its determination that the cost of a new wastewater treatment facility would be enhanced if the facility could be constructed on a site unrestricted by another existing institution, and that the removal of any existing conflicting institution would effectively serve to mitigate the impact of the location of a new wastewater treatment facility on surrounding communities.

In addition, the MWRA voted to direct its staff to work with any and all elected or appointed officials for the purpose of expediting the removal and relocation of any other institution located on whichever island it ultimately designated as the preferred alternative site for the new wastewater treatment facility. It further instructed its interim Executive Director to take certain actions to implement its position.

On July 10, 1985, the Board of Directors of the Massachusetts Water Resources Authority, in two separate votes, each ten to one, designated Deer Island as its preferred alternative for the siting of a new primary treatment wastewater treatment facility and as its preferred alternative for the siting of a new secondary treatment wastewater facility for Boston Harbor. The designations were explicitly undertaken for the purpose of completing final environmental and other precommencement review and to serve as the basis for undertaking only such additional work in the nature of planning, design, site assembly and any other work as can be accomplished prior to the availability of the Final Environmental Impact Report.

Final Selection

The following is the text of G.L.C. 30 Section 61, Findings by the MWRA on the Selection of Deer Island as the Site for Wastewater Treatment Facilities in Boston Harbor.

> On February 3, 1986, the MWRA made its final selection of a site for the proposed harbor island wastewater treatment plant. The selection of Deer Island as the location for the new facility brought to a close eight years of evaluation, discussion, comment and refinement of siting issues. Most of the history of the process followed and information explored is contained in the Supplemental Draft Environmental Impact Statement/Draft Environmental Impact Report (SDEIS/DEIR) and the MWRA's Final Environmental Impact Report on the Siting of Wastewater Treatment Facilities in Boston Harbor (FEIR).
>
> In particular, the latter document details the decision process engaged in by the MWRA from its inception in early 1985 through to its tentative selection of Deer Island as the site for the wastewater treatment facilities in July, 1985. Since July, the MWRA has continued to gather information which it has published in the FEIR, has received and evaluated comments to the FEIR including the Secretary's Certificate of Adequacy, and has reviewed EPA's Final Environmental Impact Statement and comments submitted on that document. Based on this information and on its previous examinations and evaluation, the MWRA has made its final selection. The following

sets forth the findings upon which that final site selection rests and the process by which it was completed.

DECISION PROCESS

In addition to its prior deliberations leading to the tentative selection of Deer Island as a site for the harbor island treatment plant, the MWRA evaluated two new categories of information in making its final siting selection. The first, technical information collected or refined between the July 1985, decision and the publication of the FEIR, was presented to and discussed by the MWRA Board of Directors at a series of public board meetings held throughout the fall of 1985. During these meetings, the MWRA reviewed and approved the content of the FEIR and adopted commitments to major mitigation measures contained in that document.

The second category of information reviewed by the MWRA was public and official comment to the FEIR, including the Certificate of Adequacy issued by the Secretary of the Executive Office of Environmental Affairs. In addition, the MWRA staff reviewed the Environmental Impact Statement issued by the Environmental Protection Agency and the Board of Directors reviewed the comments to that document as well as a summary of relevant distinctions between the FEIS and FEIR.

The information thus gathered was then evaluated for its applicability to the method of decision-making to be used in the final selection, for the effect of the information on the application of decision criteria to site options and for its effect on the mitigation measures to be adopted by the MWRA. A summary of that evaluation follows.

DECISION-MAKING METHOD

Selection of Criteria

The MWRA chose to maintain the eight criteria utilized in its tentative site selection process: Reliability, implementability, harbor enhancement, impacts on cultural and natural resources, costs, effects on neighbors, mitigation and equitable distribution of regional responsibilities. These criteria had been selected originally by the MWRA in response to the decision process carried out through the SDEIS/DEIR and the comments on that process. The Secretary of Environmental Affairs ("Secretary"), in his Certificate of Adequacy on the FEIR ("Certificate") approved the use of Equitable Distribution of Regional Responsibility as a means of assessing the more emotional, unquantifiable aspects of siting but opined that mitigation was better addressed only after a siting selection and not as a part of the siting decision process. As to the latter, the MWRA found that the use of mitigation as a criterion in arriving at a site selection had served a useful purpose and had contributed a focus different from the discussion of mitigation after a site was selected and that it was better to continue the decision process as already begun rather than making a major shift in the use of criteria at the culminating point in the decision process.

Weighing of Criteria

The Secretary's Certificate on the FEIR had recommended that each criterion be assigned a relative importance in the final decision. The MWRA reviewed the eight criteria selected and determined that they should be given equal weight as compared to each other.

Site Options

The MWRA, in reviewing the information gathered in light of the criteria utilized, found that a number of earlier determinations made in its tentative decision process should remain intact. Some of these determinations, once confirmed, served to eliminate certain site alternatives from consideration. For example, the MWRA confirmed its earlier tentative site decision that Nut Island was unacceptable for the construction of a treatment plant of the size contemplated, particularly with the filling of Quincy Bay which would be required. The Secretary's Certificate had acknowledged and found this conclusion to be acceptable, and other comments had only served to support this position.

The MWRA also confirmed its tentative decision that the four split plant options be rejected on the grounds that only the criteria of reliability and equitable distribution of regional impacts favored the selection of any of the split plant options, while the concerns encompassed in the remaining criteria were adversely affected by those alternatives. For example, the split island options would be more costly to construct, operate and maintain; would cause aggravated impacts to a wider universe of neighbors -- thus causing the need for greater mitigation; would be more difficult to implement because of the need to obtain approximately twice as many permits; and did not significantly lessen the impact of single island alternatives on cultural or natural resources or harbor enhancement. There was no additional or different information presented to persuade the MWRA to change this position.

As a result of these findings concerning site alternatives, the MWRA was left with a comparison of all Long Island and all Deer Island as possible sites for the harbor facility. A summary of the analysis of these two site alternatives in light of each of the criteria used and the information gathered as it affected those criteria, and the conclusions reached, follows.

APPLICATION OF DECISION CRITERIA TO THE ALL LONG ISLAND AND ALL DEER ISLAND SITE ALTERNATIVES

CRITERIA WITH NO SITE DETERMINATIVE EFFECT

In examining Long Island and Deer Island in light of the eight criteria, the MWRA found two criteria, reliability and effects on neighbors, to be of relatively equivalent value and therefore not to be site determinative.

Reliability

The MWRA had previously found reliability to be non-site determinative in its tentative decision because the size and configuration of each of the islands presented the same potential for use of design and layout to provide for reliability of the waste treatment system. The MWRA, in its current evaluation on reliability, noted that no new information had been presented to change that determination and confirmed its earlier decision.

Effects on Neighbors

The MWRA also found the effects on neighbors to be roughly equivalent between the two islands. As before, effects on neighbors were reviewed in six components: traffic impacts, noise impacts; odor impacts; visual impacts; property value impacts and safety impacts.

Traffic

Following its initial determination that the traffic impacts were comparable between the two sites, the MWRA commissioned a study to augment information provided in the SDEIS/DEIR traffic analysis. This analysis examined roadway conditions, assembled traffic counts, determined the present level of service on the roadways (LOS), and evaluated the impact of expected construction traffic. The MWRA concluded that for the predicted level of construction related traffic there was sufficient roadway capacity leading to each site during peak hours and that the impact although somewhat worse at some intersections for access to Long Island, was relatively comparable.

The MWRA also further explored the feasibility of barging, identifying the types of barging and/or water transportation that might be needed and sites that could be utilized. The MWRA made commitments to a level of barging, to caps on construction-related traffic and to busing of workers, all of which is set out in the Commitments to Mitigation section below.

The MWRA reviewed traffic-related comments received on the FEIR. The MWRA concluded, based on its original evaluation and the additional traffic information and comments collected since its tentative decision and its strong commitment to mitigation measures, that the traffic impacts remained roughly equal and did not favor either island.

Noise

The MWRA, in its tentative decision, adopted the then current position of EPA that noise levels at Deer Island would result in greater impact to neighbors, particularly the close neighbors at the House of Correction. However, that position was predicated on EPA's view that Long Island as a site for the treatment plant could not contain the Long Island hospital whereas the Deer Island site could encompass the House of Correction.

The MWRA in its final selection compared the sites equally, i.e. both sites with existing

institutions and both sites without those institutions. The MWRA concluded that when the sites without institutions were compared, there was more noise impact on neighbors at Deer Island than at Long Island. If the sites were compared with the institutions present, then the severity of impact on the residents or workers at each institution was equivalent.

To explore whether noise levels at Deer Island could be kept at acceptable levels, the MWRA retained an acoustical consultant to evaluate expected noise levels during both construction and plant operation for the Deer Island site. The consultant also furnished information to the Board on existing acoustical conditions, applicable regulations and an evaluation of the expected effectiveness of noise mitigation measures.

The MWRA concluded that for the nearest residence the noise levels from both construction and operation were within applicable legal standards. Furthermore, during the daytime the projected noise would be indistinguishable as compared to the existing ambient levels. At night, with a minimum of construction to be anticipated, nighttime noise would not be an impact. During plant operation, if power was generated on-site, a slight increase in background levels over existing levels was determined to be likely.

Based on this information and upon review and assessment of comments on noise, the MWRA concluded that while noise impacts upon receptors other than the current institutions would be greater at Deer Island, those impacts could be maintained at acceptable levels. The MWRA also found that the noise impacts at Deer Island prison or Long Island Hospital, because of the proximity of those institutions, would raise the noise levels above the legal standard and would require extraordinary mitigation measures to be adopted.

Odor

Odor studies conducted on behalf of the EPA have indicated that potential odor impacts on neighbors are comparable, regardless of plant location. This confirmed the MWRA's tentative decision that the issue of odor was not site determinative. The MWRA further recognized that odor control was a paramount concern and that stringent odor controls would be utilized no matter where the treatment plant was located. As a result of further work presented since its tentative selection, the MWRA concluded that control stystems such as wet scrubbers and carbon absorption columns would likely be effective in controlling the odors. The MWRA confirmed its tentative decision that odor impacts were not site determinative and committed itself to a limit of no detectable odor off-site as well as a goal of no objectionable odor on-site.

Property Values

Reviewing trends in real estate values and the impacts of other noxious facilities on property values, the MWRA confirmed its tentative decision that the effect on property values, to the extent that that effect could be predicted, was not site-determinative.

Visual Impacts

In its tentative decision the MWRA determined that a treatment plant on either island have a negative impact on persons in the existing institutions due to proximity. With respect to residential neighbors, it was determined that if the institutions remained, there would be a somewhat greater negative impact from a treatment plant on Deer Island. If the House of Correction were removed, however, modifying land forms and landscaping could be used to screen the treatment plant from most residences.

Health and Safety

Health and safety concerns of the community -- such as traffic impacts on schools and the elderly, chlorine delivery, air quality reduction from traffic or the facility operation -- were examined and found once again not to be site-determinative factors.

Summary of the Effects on Neighbors

Most of the effects considered within each of the subcategories of effects on neighbors were found to be roughly equivalent between Long Island and Deer Island. For those two categories in which a somewhat more negative impact was discerned for Deer Island, noise and visual impact, the degree of difference in impact was not sufficient to change the balance of effects on neighbors between the two sites.

SITE DETERMINATIVE CRITERIA

The MWRA found the remaining six criteria to have a site-determinative effect. Five of the criteria favored the selection of Deer Island while one criterion, equitable distribution of regional responsibilities, favored the selection of Long Island. A summary of that analysis follows.

Equitable Distribution of Regional Responsibility

Just as in its tentative decision, the MWRA found in its final site selection that this criterion favored the selection of Long Island over Deer Island. The impacts of other regional uses such as Logan Airport, Deer Island House of Correction and the current Deer Island treatment plant were found to have greater impact on Deer Island neighbors than the airport and other regional facilities had on Long Island neighbors. The MWRA concluded that it was more unfair to site the harbor facility at Deer Island.

Cost

The MWRA again found this criterion to favor selection of Deer Island. There was no change to the cost information upon which the MWRA had made its tentative decision. Those figures still showed the construction of a treatment plant on Deer Island to be less costly than a facility at Long Island. While noting that EPA had found this criterion to

be non-site determinative and that the Town of Winthrop had concurred with this conclusion, the MWRA recognized that this reflected a value judgment by the EPA and Winthrop of the relative unimportance of the dollar difference which both EPA and MWRA agreed existed rather than different information as to the cost figures themselves. The MWRA, as the operator of the system felt that the difference in cost between the two sites was of site significant importance.

Implementability

In its tentative decision, the MWRA found implementability to be non-site determinative. The information which the MWRA had reviewed at that time covered the permitting and land acquisition issues and, based on the assessment that the numbers and types and timing considerations of permits and approvals were generally the same, had concluded that the criterion was relatively equivalent between the sites. The MWRA also noted at that time that the removal of the House of Correction from Deer Island was far more implementable than the removal of the hospital from Long Island due to the expressed support for the former by those in a position to effect the removal.

Two factors have been added to the implementability discussion since the tentative decision, however, which have caused the MWRA to change its conclusion about this criterion. The first is the concurrence in the approval by the Secretary of the selection of Deer Island as the site for the treatment plant. The second is the selection of Deer Island by the EPA as its preferred alternative. The choice of Deer Island as the preferred site by both a state regulator and a federal regulator, each of which has responsibilities in further permitting or approvals concerning the construction and operation of the treatment plant and related facilities, increased the likelihood of successful and expeditious processing of the many regulatory reviews and permits pertaining to the Deer Island site. It also suggests a facilitating of the disposition of federal land located on Deer Island. In light of these factors, the MWRA has found in its final siting decision that implementability is no longer non-site determinative and that it weighs in favor of selecting Deer Island.

Harbor Enhancement

A further exploration into recreational potential of Deer Island conducted during the tentative decision process was completed for the FEIR and confirmed what had already been suggested during the tentative decision process: that a greater potential existed for Deer Island than had been suggested in the SDEIS/DEIR. However, the possibility of this greater potential had been discussed when the MWRA made its tentative selection and its confirmation did not change the MWRA's determination that harbor/enhancement favored siting the treatment plant at Deer Island. The MWRA still found that Long Island's recreational resources included natural and undeveloped aspects which could not be recreated if lost; that Long Island as a park could be brought to reality sooner since it did not have sited on it both a prison and a current treatment plant which had to continue operating until the new plant was on line; that there were indications that official support and dollars had already been or could readily be mobilized to make a park on Long

Island a reality; and, finally, that the adverse visual impact on the harbor was greater from a treatment plant on Long Island because of the Island's position in the harbor and its configuration.

Effect on Natural and Cultural Resources

In examining the natural and cultural resources of each island, the MWRA took into consideration additional pieces of information received since its tentative decision. In particular, the MWRA considered the results of a study, which it had commissioned, of parts of Deer Island which had never been adequately evaluated before for the existence of archaeological or historical resources. That study confirmed the existence of a cementery in the northeastern part of the island and also confirmed the potential eligibility of the Deer Island pump station and portions of the Deer Island House of Correction complex for nomination to the National Register. Subsequently, the Massachusetts Historical Commission found that the pump station, and two buildings in the prison complex met National Register criteria. In its comments on the FEIS, the Commission also noted that Long Island in its entirety had been nominated to the National Register as a component of the Boston Harbor Islands Archaeological District, that the Long Island hospital complex also met National Register criteria of eligibility and that historic burial grounds existed on Long Island.

All the information received concerning these resources was a confirmation of material already considered to be potentially true during the MWRA's tentative decision. The MWRA found, as it had in its tentative selection, that Long Island possessed more resources and more unique resources than Deer Island and that these resources, particularly the unique resources, would be adversely impacted by the siting of the harbor treatment plant facility on Long Island.

The MWRA noted that EPA had found this criterion to be non-site determinative but recognized that EPA had hypothesized layouts which could avoid these resources without fully exploring the technical feasibility of those layouts. The MWRA had assured that the layouts upon which their conclusions rested were technically feasible.

Mitigation

The MWRA utilized the criterion of mitigation to focus on and clearly consider those actions which might be or ought to be taken with regard to a particular site to make it more acceptable. The utilization of this criterion in the siting decision process brought to the fore and highlighted mitigation measures which might be site specific and permitted the MWRA to weigh the need for those measures in its siting selection. Early analysis of mitigation needs during the decision process also laid the groundwork for a thorough understanding and appreciation of mitigation measures to be adopted once a site was chosen. The mitigation measures to which the MWRA finally committed itself in the implementation of its site selection of Deer Island are contained in the Commitments to Mitigation section which follows.

With respect to the effect of the mitigation criterion in the siting selection process, the MWRA confirmed its earlier finding that mitigation favored the selection of Deer Island.

While various measures to mitigate construction and operation impacts such as noise and odor or the destruction of natural or cultural resources might shift the balance slightly toward one site or the other within each of those categories, the total number of kinds and degree of mitigation required for one site or the other tended, with one exception, to balance out roughly equal as a whole. The one exception was the mitigation measure of relocating the existing institutions. The MWRA found in its tentative decision and confirmed in its final decision that it was critical to relocate whichever existing institution was located on the chosen site due to the adverse environmental effects which accrued from constructing the treatment plant on a constrained site in close proximity to the particular institution. However, the MWRA also found that there was more net benefit to building the treatment plant on Deer Island and removing the House of Correction than building on Long Island and removing the Long Island Hispital since removal of the House of Correction would favorably affect property values and the safety of the curreunding community and would promote equitable distribution of regional facilities. Further details as to the findings of the MWRA regarding the removal of the existing institutions and the Deer Island House of Correction in particular is contained in the Commitments to Mitigation section which follows.

Final Siting Decision

Having found two criteria effectively neutral between Long Island and Deer Island (Reliability and Effects on Neighbors), one criterion favoring the selection of Long Island (Equitable Distribution of Regional Responsibility) and five criteria favoring selection of Deer Island (Cost, Implementability, Harbor Enhancement, Effects on Natural and Cultural Resources and Mitigation), and having given each criterion equal weight, the MWRA determined that the most appropriate site for the harbor island wastewater treatment facility is Deer Island.

COMMITMENTS TO MITIGATION

Recongizing the need to adopt all feasible measures to mitigate the adverse environmental impacts, the MWRA, as part of the FEIR, set forth a series of mitigation commitments designed to alleviate the impacts associated with the construction and operation of the Harbor Islands plant. During the process of making its final siting decision the MWRA reviewed the public comments on the proposed mitigation commitments and the comments received from the Secretary of Environmental Affairs and adopted a final series of mitigation commitments. This section sets out those commitments.

--Commitments on Flow and Growth
--Commitments on Plant Maintenance
--Commitments on Odor Control

--Commitments on Noise
--Commitments on Barging
--Commitments on the Use of Liquid Chlorine
--Commitments on the Relocation of the Deer Island House of Correction

Commitments on Flow and Growth

Recognizing the need for responsible management and being sensitive to the possible need for expansion of the proposed Harbor Islands treatment plant, the MWRA has made the following commitments with respect to flow and growth:

- The MWRA will undertake all necessary and prudent planning and management initiatives to avoid overloading the Harbor Islands treatment plant.

- The MWRA will not expand the treatment plant capacity unless or until it has implemented flow management techniques and has developed and implemented a program to avoid excess pollutant loading. These techniques and programs include:

    - Conducting infiltration/inflow reduction programs

    - Instituting water conservation programs that can reduce wastewater flows

    - Pricing of water and sewer services to promote the conservation of water, thus reducing wastewater flows

    - Controlling pollutant loads through pricing strategies and pretreatment programs

    - Controlling both flow and loads through regulatory controls, such as flow reduction programs to compensate for new connections

    - The MWRA will develop monitoring and triggering programs so that it will be able to test the effectiveness of the flow management techniques and to provide the MWRA with the ability to determine when planning for the MWRA's next increment of treatment capacity should be undertaken

- If the MWRA determines, through its monitoring and triggering programs, that the flows and loading are increasing at rates higher than projected in the FEIR, it will take all necessary steps to plan, design, and construct ancillary facilities including (but not limited to):

    - Flow control structures, such as on-line and off-line storage to minimize peak flows at the plant

    - Septage treatment facilities to reduce pollutant loadings on the Harbor Islands plant

- If the ancillary facilities are insufficient to accommodate increased flow and loading and to prevent exceeding the design capacity of the Harbor Islands treatment plant, the MWRA will take all necessary steps to plan, design, and construct satellite treatment plants unless it determines it would be economically or environmentally infeasible to do so.

- Notwithstanding the foregoing, the MWRA does not intend the adoption of the above commitments to require the postponement or cancellation of any capital program contained in the Authority's Fiscal Year 1986-88 capital budget that services to eliminate an existing problem of sewage backups.

The purpose of these commitments is to confirm the MWRA's desire to establish a sound and rational program for assessing future capacity needs, to respond to public concerns on overloading and future system expansion, and to provide a framework within which additional capacity will be planned.

Commitments to Operation and Maintenance

MWRA has already made clear its commitment to improved operations and maintenance by approving both a substantially increased operating budget and by authorizing significant increases in operations and maintenance staff for existing facilities. MWRA's commitment to maintenance is underscored by their adoption of the following assurances:

- Review of Recurrent Budgets. Annual operating budgets will be carefully scrutinized to be certain that these budgets reflect not only a sound maintenance program for existing facilities but that the budgets reflect any new facilities expected to be in service during the budget year. The MWRA will link budget expenditures with performance indicators that reflect the efficiency and effectiveness of the maintenance programs.

- Renewal/Replacement Expenditures. More than $100 million in construction projects have been initiated at the Nut Island and Deer Island treatment plants to replace much of the antiquated equipment at these plants. These upgraded programs are expected to be completed in 1989 and will contribute significantly to the reliability of the existing plant equipment. Capital budgets in future years will continue to reflect the important role that R/R plays in the maintenance of treatment facilities. The MWRA's maintenance procedures will be modified at an early date to incorporate record keeping procedures that will provide a rational basis for R/R investment in future years.

- Review of Maintenance Procedures. Prior to the completion of the on-going upgrade program, the MWRA will initiate a review of its existing maintenance procedures. Strengthened maintenance procedures will be designed including an aggressive housekeeping and preventive maintenance program. These procedures will be amended as new treatment facilities are constructed.

- o <u>Initiate Early Planning.</u> To ensure that operations and maintenance considerations are included as an integral part of the planning for all new facilities, MWRA will require that the plant's facilities plan include a preliminary plan of operations. The preliminary plan of operations will identify the additional or unique O & M requirements of the recommended facilities, including staffing and special training needs, manuals, special tools and workshops, and estimated budget considerations. This preliminary plan of operations will provide MWRA with two to four years' lead time prior to completion of facilities to incorporate the maintenance requirements of new facilities into on-going maintenance programs.

- o <u>Adoption of Performance Indicators.</u> MWRA will adopt performance indicators into the agency's proposed management information systems that will permit the Authority to review on a regular basis the level-of-effort and the performance of the maintenance activities. Indicators such as plant performance, equipment availability, maintenance labor/expenditures, custodial inspection reports, spare parts inventory, and equipment age will be monitored to regularly examine the efficiency of the maintenance efforts. Additionally, the Authority will involve the community in reviewing maintenance programs to provide focus on issues of local importance.

<u>Commitments on Odor Control</u>

The MWRA commits to the construction of the treatment pant that will control odors so as to eliminate detectable odors off-site and to control odors as necessary to protect the public health. Furthermore, the MWRA commits to the control of odors so as to minimize, to the maximum extent feasible, objectionable odors on-site.

The type of odor control needed will be selected during the facility planning effort. Sampling of the odor potential characteristics of the influent wastewater will be conducted as part of the facilities planning to provide the necessary data to develop a program of source control and to size and select the odor control equipment.

The most reliable means of measuring odor performances is the human nose. In order to measure the plant odor performance, an odor panel will be created composed of individuals from the community as well as individuals from the MWRA. The panel will routinely monitor for odors to ensure that no objectionable odors are occurring off-site. The panel will also respond to odor complaints received by the plant, by assisting in the investigation of the odor and recommending odor control techniques.

<u>Commitments on Noise Control</u>

The MWRA is committed to complying with all the legal standards of both City of Boston noise control ordinance and the Department of Environmental Quality Engineering.

Because of the scale of the proposed plant, however, the MWRA is setting as a goal noise abatement that goes beyond simply adhering to the City of Boston code. The MWRA has

to define, by the FEIR, what noise levels may be achievable and will examine means of noise abatement throughout the planning, design and operation of the facility.

The MWRA further commits to the development of a program for avoiding adverse noise impacts, the components of which shall be resolved during facilities planning but which shall include the following:

- The establishment of an Acoustical Review Board. The Acoustical Review Board will include representatives from the community as well as engineers and MWRA staff.

- The use of available and feasible noise control techniques, which may include items such as the evaluation of the acoustical characteristics of operational equipment and flexible scheduling of construction activities to minimize noise.

- The establishment of necessary training and hiring practices to assume the best possible control of noise impacts.

- The involvement of the community in the development of noise control programs and the participation of community representatives in those programs.

Commitment on Barging and Busing

The determination that barging and busing are necessary is a direct consequence of the volume of traffic associated with the construction of the proposed facility and the limited capacity of roadways leading to the plant site. The Traffic section of the FEIR describes the capacity of the roadways. The commitment to barging, therefore, also requires a commitment to maximum traffic levels associated with the construction of the plant. Those traffic levels are defined for both the pier construction period and for the period thereafter.

Prior to construction of the piers, it is not feasible to barge materials to the site. Therefore, the MWRA has given a high priority to the identification of barge sites, design of pier facilities and construction of those piers. The Authority is engaged in the selection of a consultant for the necessary barge and pier facilities. The MWRA commits to limiting the trucking of materials for construction of the piers to a maximum of 20 trucks per day.

Upon completion of the pier facilities, the barging of almost all heavy construction equipment and materials is, based on the analyses conducted to date, an achievable level of barging. The level of commitment is conditioned, however, to allow for contingencies that may result from scheduling or operational problems. The extent of such contingency trucking, after the completion of the piers, will be limited to a service fleet of eight trucks. Also, in order to minimize impacts associated with commuting of construction workers to the plant site, the Authority has committed to the busing of all workers, using a maximum of 28 buses per day.

In addition, the Authority will undertake an evaluation of the practicality of providing ferries to transport construction workers to the job site.

Commitments on the Trucking of Liquid Chlorine

The MWRA has committed to cease the trucking of liquid chlorine through the streets of Winthrop as soon as possible when water access facilities become operable and the transport of alternate disinfectant or barging of liquid chlorine becomes feasible.

Commitment on Relocation of the Deer Island House of Correction

The MWRA has determined that the Deer Island House of Correction must be relocated from Deer Island by those parties with jurisdiction over its operation and that such relocation must be deemed a mandatory mitigation measure.

The MWRA's conclusion with respect to this mitigation measure is based on its findings throughout the tentative and final site decision process relative to the environmental impacts resulting from the construction of the harbor island treatment plant on either island with the existing institutions present, and the benefit to be gained by the removal of the existing institution from the island selected as the site for the treatment plant. Many of those findings, as they relate to Deer Island were addressed by the Secretary in his Certificate as well as by numerous commentors to the FEIR, all of whom found the relocation of the prison to be a required mitigation measure. The MWRA's findings on benefits which would result from relocation of the prison are summarized as follows.

The MWRA found that the reliability of the treatment plant would be greatly enhanced by providing sufficient space for optional design. The converse was also found, that building on Deer Island with the treatment plant present would require a cramped design with reduced space between piping and flow controllers resulting in decreased uniformity of flow and reduced control over the treatment process. This, in turn, would increase the possibility of operational malfunctions or decrease the ability to monitor or redress such episodes, resulting in adverse impacts on neighbors of the treatment plant.

The MWRA also found that building the treatment plant in such close proximity to the prison would cause severe visual and noise impacts on the persons living and working in that institution. The noise impacts on the prison would be above the legal standard and would require extraordinary mitigation measures to be undertaken to ameliorate the effect. Mitigation measures, such as buffers or berms, would place additional area demands on an already constrained site. Other measures, such as timing and placement of construction and equipment could adversely impact the length of construction time. Removal of the prison would eliminate such impacts and the need for such mitigation measures.

Relocation of the prison would also reduce costs. The cost of constructing the treatment plant on a constrained site with the prison present, of operating and maintaining the plant under those conditions, and of providing the necessary mitigation measures to

alleviate the proximity of the treatment plant to the prison would be significantly greater than building without the prison.

Finally, additional benefits to recreators and to non-prison receptors would accrue from the removal of the prison. Those benefits would include alleviating the visual impact of the treatment plant on Winthrop receptors by providing space for screening and modifying landforms, providing space for recreational and open land use, reducing traffic on Winthrop's streets by the approximately 114 autos a day currently used at the prison, substantially alleviating the combined impact of regional facilities on the Town of Winthrop and by enhancing the safety of the community.

For all these reasons and the reasons cited by the Secretary, some of which are echoed by other commentors, the MWRA considers the removal of the Deer Island House of Correction to be essential to the expeditions construction of new treatment facilities.

Further Measures to be Examined

The commitments to mitigation listed above comport with all mitigation measures which would be required under the MEPA statute. In fact, in many instances, as noted by the Secretary in his certificate on the FEIR, the MWRA has addressed many issues to a far greater degree than was required and has made commitments in these areas accordingly.

Nevertheless, the Secretary, in his final Certificate, has made recommendations that certain measures be undertaken either sooner than might be required or with respect to current facilities as opposed to the new treatment plant which is the subject of the FEIR.

The MWRA considers these suggestions positive and worthy of serious review. It has directed staff to evaluate the Secretary's suggestions and to recommend within thirty to ninety days where, when and how they may be responded to and the nature of the recommended response. The suggestions by the Secretary include:

1. The "Sewer Bank" concept be further explored and feasible programs developed to eliminate excess flow and accommodate new connections.

2. Accommodate future growth within the service area through satellite plants.

3. Continued and strengthened programs to monitor flows to provide sound data to gauge the effects of flow management.

4. Implement odor panel and formal odor complaint response at existing facility.

5. Consider real time monitoring of odors, perhaps using hydrogen sulfide as an indicator.

6. Consider development and implementation of a monitoring program for VOCs and other air toxics in the wastewater stream and in the ambient air.

7. Recommend implementation of an acoustic Review Board to monitor and respond to noise complaints at existing facility; and supplement such a noise program now and at the new treatment plant with periodic noise monitoring.

Summary of Impacts and Findings of Limitation of Impacts

The MWRA finds that the environmental impacts resulting from the construction of the Boston Harbor wastewater treatment facility are those impacts as described in the Draft Environmental Impact Report, elaborated on and refined in the Final Environmental Impact Report and commented upon in these G.L.C. 30, Section 61 Findings.

The MWRA further finds that its selection of Deer Island as the site for the wastewater treatment facility, and its commitment to the mitigation measure set out in the Commitments to Mitigation section of these G.L.C. 30, Section 61 Findings constitute all feasible measures to avoid or minimize the environmental impacts described.

Record of Decision

The text of EPA Region I's Record of Decision on the Final Environmental Impact Statement Siting of Wastewater Treatment Facilities for Boston Harbor is as follows:

> The U.S. Enviromental Protection Agency (EPA) has prepared this document as its Record of Decision (ROD) for the Final Environmental Impact Statement (FEIS) on the siting of the Massachusetts Water Resources Authority (MWRA) wastewater treatment faciities which will abate the pollution of Boston Harbor.
>
> The MWRA has the responsibility of selecting the site for the wastewater treatment facilities. EPA's primary responsibilities are to conduct an evaluation of environmental acceptability under the National Environmental Policy Act (NEPA), provide federal financial assistance if available, and ensure rapid compliance with the Clean Water Act.
>
> EPA issued a Supplemental Draft EIS (SDEIS) in December, 1984 and a FEIS on December 2, 1985 on the siting of wastewater treatment facilities for Boston Harbor. These documents evaluated the environmental impacts of various site options for facilities to treat Greater Boston's wastewater in compliance with water pollution control laws. The SDEIS also served as a Draft Environmental Impact Report (DEIR) under the provisions of the Massachusetts Environmental Policy Act (MEPA) for the Metropolitan District Commission (MDC). Since publication of this joint document, the sewer functions of the MDC have been reorganized into the MWRA. The Board of Directors of the MWRA chose to follow an independent but parallel decision process and to publish a separate but concurrent Final Environmental Impact Report (FEIR) under state law.

Following the concurrent publication of EPA's FEIS and MWRA's FEIR, EPA and MWRA conducted joint public hearings before reaching their respective final decisions. Public hearings were held on January 13, 14 and 15, 1986 in Quincy, Boston and Winthrop. Oral and written comments were submitted during the comment period. The public comment period ended on January 21, 1986 for the FEIS and January 24, 1986 for the FEIR.

In February, 1986, the MWRA determined that "the most appropriate site for the harbor island wastewater treatment facility is Deer Island." This ROD identifies EPA's final decision on the siting issue. This ROD is being circulated to inform the public of this decision and to respond to the comments on the FEIS.

I. EPA's FINAL DECISION ON THE SITING OF SECONDARY WASTEWATER TREATMENT FACILITIES FOR BOSTON HARBOR

With the understanding that EPA will require the MWRA to carry out the program of specified mitigation measures identified on pages 52-55 of the FEIS, Volume I, EPA's decision is that its preferred alternative is the All Secondary Deer Island alternative set forth in the EIS and described below. All Secondary Long (without the hospital) is also environmentally acceptable and is preferred over Split Secondary Deer-Long (without the hospital). The only alternative which EPA finds unacceptable is Split Secondary Deer-Nut. The decision process and the program of required mitigation measures is described in more detail in Section III.

EPA's preferred alternative for secondary treatment, All Secondary Deer, would expand the existing primary wastewater treatment facility at Deer Island to a secondary treatment plant. It would reduce the existing primary treatment facilities at Nut Island to a small headworks. It would include construction of a major new pipeline or tunnel from Nut Island to Deer Island and of an effluent outfall to the east of Deer Island Light. The existing wastewater treatment facility on Deer Island would be increased from 26 acres to about 115-140 acres while on Nut Island the existing wastewater facility would be reduced from 12 acres to about 2 acres.

This alternative would commit almost all the land on Deer Island south of the existing prison to wastewater treatment and level the most prominent topographic features of the island. This alternative would also require the construction of a bulk materials loading pier(s) and roll-on roll-off facilities at the site, and associated terminal(s) on-shore.

The estimated construction cost of this alternative would be about $1.135 billion and its annual cost of operation, maintenance and replacement would be about $50 million. Costs, acreage requirements, exact plant layout and mitigation measures will be developed in greater detail during further facilities planning on the project.

The Benefits of Moving the Prison

The MWRA favors a variation of the All Secondary Deer Island alternative which assumes that the prison would be removed as a mitigation action, and that its site would be made available for the treatment plant. This variation would also use most of the Island but prison removal would reduce the impacts of the treatment plant in several ways:

1. It would remove the receptor population (the prison workers and inmates most affected by the plant's impacts, including noise and odor.

2. It would eliminate prison-related traffic, thus offsetting construction-related and operations traffic for the treatment plant.

3. It would improve the appearance of Deer Island by removing the prison buildings.

4. It would permit opportunities for sculpting the landscape to a more natural appearance and for screening the facility from both the harbor and Point Shirley and Cottage Hill in Winthrop.

5. It would increase the opportunity for buffering noise at Point Shirley by earthen barriers on prison property.

6. It would permit the retention of a portion of the Island's shoreline for buffering and recreation.

7. It would remove prison-related anxieties from Winthrop.

8. It would make more land available for the wastewater treatment facility, possibly making construction and maintenance easier.

This variation does not eliminate the need for any of the mitigating actions proposed for the All Secondary Deer Island alternative with the prison to remain, except for those intended to reduce impacts at the prison itself, e.g., a noise barrier.

However, the process required to release the Deer Island prison site for treatment plant use could be so lengthy as to delay or frustrate the construction of this variation of the All Secondary Deer Island alternative. EPA has long advocated removal of the prison if Deer Island is to be the treatment plant site, but EPA will not require removal of the prison as a grant condition. Implementation of secondary treatment is required by the Clean Water Act and cannot be made dependent upon removal of the prison if the site is acceptable.

This ROD concludes that in EPA's judgement the All Secondary Deer Island Alternative is its preferred alternative and can be implemented without unacceptable environmental

impacts even if the prison remains.*

II. SELECTION OF ALTERNATIVES FOR EVALUATION

Federal regulations require EPA, during environmental review, rigorously to explore all reasonable alternatives for the siting of wastewater treatment facilities for Boston Harbor. Most of the alternatives initially investigated were derived from the EPA's 1978 Draft Environmental Impact Statement (DEIS), which examined only secondary treatment options, and the MDC's 1982 Nut Island Site Options Study. The Site Options Study identified eleven alternatives (eight secondary and three primary treatment alternatives), including some previously examined in the DEIS. In September, 1983, EPA and the Commonwealth conducted two public scoping meetings to receive comments on these initial alternatives from the public and from federal, state and local officials. Upon completion of the joint scoping meetings, EPA selected eleven additional alternatives for analysis, for a total of twenty-two alternatives to be studied. These included twenty alternatives for treatment at Deer, Long, Nut, or man-made islands and two alternatives including sub-regional "satellite" plants. A complete discussion of the twenty-two initial primary and secondary alternatives appears in the SDEIS at Vol II, Section 12.12. Table I is a complete list of the twenty-two initial options.

[See Table 1 on page 39 of this document.]

III. DECISION PROCESS

To examine such a large number of alternatives, a screening process was developed jointly with the Commonwealth. Its objective was to narrow the number of alternatives being investigated and to eliminate those that clearly offered few benefits or had significant adverse impacts. This initial screening of alternatives is summarized here; it is described in detail the SDEIS. Each alternative's economic, social and environmental impacts were studied. In addition, their technical, legal, institutional and political problems were also analyzed. Specific criteria were developed for comparison and screening of the options.

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* The Clean Water Act requires that wastewater treatment plants be constructed which will provide "secondary" treatment unless EPA, under strict statutory guidance, grants a waiver, under Section 301(h) of the Clean Water Act, permitting a lesser "primary" degree of treatment with a deep ocean dicharge. EPA has twice denied the MDC/MWRA request for such a waiver but final rights of appeal have not expired. EPA believes it is highly unlikely any such appeal, even if pursued, would prevail on the merits, or that the discharge of primary effluent into Massachusetts Bay would ultimately be permitted over the opposition of the Governor and other officials. However, in the interest of completing the NEPA review, EPA has decided in this ROD to resolve the siting of a primary treatment plant as well. The decision is the All Primary Deer Island alternative.

TABLE I

LIST OF TWENTY-TWO INITIAL OPTIONS STUDIED IN THE SDEIS

Secondary Treatment Alternatives

1a.1 Secondary Treatment at Deer Island, Headworks at Nut Island with separate North and South System Secondary Treatment Processes.

1a.2 Secondary Treatment at Deer Island, Headworks at Nut Island with combined North and South System Secondary Treatment Processes.

1b.1 Secondary Treatment at Deer Island, Primary Treatment at Nut Island for South system, separate North and South System Secondary Treatment Processes.

1b.2 Secondary Treatment at Deer Island, Primary Treatment at Nut Island for South System, combined North and South System Secondary Treatment Processes.

1c Secondary Treatment at Deer Island for North System, Secondary Treatment at Nut Island for South System.

2a.1 Secondary Treatment at Deer Island for North System, Secondary Treatment at Long Island for South System, Headworks at Nut Island.

2a.2 Secondary Treatment at Deer Island for North System, Secondary Treatment at Long Island for South System, Primary Treatment at Nut Island.

2b.1 Headworks at Deer Island for North System, Headworks at Nut Island for South System, Consolidated Secondary Treatment at Long Island.

2b.2 Primary Treatment at Deer Island for North System, Primary at Nut Island, Consolidated Secondary Treatment at Long Island.

2b.3 Headworks at Nut Island, Primary Treatment at Deer Island for North System, Consolidated Secondary Treatment at Long Island.

3a Headworks at Deer and Nut Islands, Consolidated Secondary Treatment at Lovell's Island.

3b Headworks at Deer and Nut Islands, Consolidated Secondary Treatment at a new man-made island.

Primary Treatment Alternatives

4a.1 Primary Treatment of All System at Deer Island, Headworks at Nut Island. Local Outfalls.

4a.2 Primary Treatment of All System at Deer Island, Headworks at Nut Island, Deep Ocean Outfalls.

4b.1 Primary Treatment at Deer Island for North System, Primary Treatment at Nut Island for South System, Local Outfalls.

4b.2 Primary Treatment at Deer Island for North System, Primary Treatment at Nut Island for South System, Deep Ocean Outfalls.

5a.1 Primary Treatment at Deer Island for North System. Primary Treatment at Long Island for South System, Headworks at Nut Island. Local Outfalls.

5a.2 Primary Treatment at Deer Island for North System, Primary Treatment at Long Island for South System, Headworks at Nut Island. Deep-Ocean Outfalls.

5b.1 Headworks at Deer and Nut Islands, Consolidated Primary Treatment at Long Island. Local Outfalls.

5b.2 Headworks at Deer and Nut Islands, Consolidated Primary Treatment at Long Island. Deep-Ocean Outfalls.

Satellite options 1&2 - Satellite facilities for South System with discharge to Charles and Neponset Rivers. Satellite facilities for South System with wetlands discharge.

In screening the initial alternatives, it became clear that no alternative was without some potentially adverse impacts. Furthermore, no alternative satisfied all of the criteria used in the analysis. Considering the size and complexity of the project, virtually all alternatives were considered to have at least one or more drawbacks that limited their acceptability to some affected group(s).

The initial screening process concluded that of the twenty-two alternatives studied, four secondary treatment options and four primary options conformed to these criteria and warranted further investigation and more detailed study. These alternatives reflected different approaches to the siting requirements of the MDC system. The impacts of these options also varied in their respective advantages and disadvantages. The eight alternatives are identified below according to their abbreviated names used in the EIS. (Parenthetical references in Table I refer to the nomenclature used in the initial screening process.)

a. <u>Secondary Treatment (Harbor Entrance Outfall) Alternatives:</u>

1. All Secondary Deer Island (1a.2)
2. Split Secondary Deer Island and Nut Island (1b.2)
3. All Secondary Long Island (2b.1)
4. Split Secondary Deer Island and Long Island (2b.3)

b. <u>Primary Treatment (Nine Mile Outfall) Alternatives:</u>

1. All Primary Deer Island (4a.2)

2. Split Primary Deer Island and Nut Island (4b.2)

3. All Primary Long Island (5b.2)*

4. Split Primary Deer Island and Long Island (5a.2)

A detailed assessment of the impacts of these alternatives was provided in the SDEIS. Figure I shows the eight alternatives with their respective facilities and harbor locations.

During the further preparation of the SDEIS, relevant Massachusetts agencies and the EPA agreed that it was necessary to refine the decision process because of the complexity of the siting decision and the great number and variety of factors which must be taken into account by decision-makers. The first step was to re-analyze the various arguments and considerations that had been brought to bear on this controversial siting decision by all concerned parties in order to determine their disparate objectives. These objectives were used to develop a more precise set of decision criteria against which the remaining alternatives were to be evaluated. It was the goal of the SDEIS to make the list short, yet inclusive of all concerns that had been raised. Six decision criteria were identified. Each alternative was to be evaluated to determine the extent to which it:

1. is consistent with and, if possible, promotes the fulfillment of the promise of Boston Harbor. (Harbor Vision)

2. can be implemented in a timely and predictable manner. (Implementability)

3. minimizes the adverse impacts of the facility on neighbors, taking into consideration existing conditions, facility siting impacts and mitigation measures. (Effects on Neighbors)

4. minimizes the impacts of the facilities on natural and cultural resources. (Impact on Cultural and Natural Resources)

5. can be built and operated at a reasonable cost. (Cost)

6. maximizes the reliability of the entire treatment system. (Reliability)

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* Though the SDEIS/EIR suggested that one alternative, All Primary Long, should also be screened out and not receive further active consideration, the SDEIS/EIR and the FEIS contained a full evaluation of All Primary Long. EPA considers that all eight alternatives received an equal level of analysis.

Finally, EPA and the Commonwealth developed a comprehensive program of mandatory measures applicable to all alternatives: barging of materials, busing of workers, and noise and odor control.

Thus, in the SDEIS/EIR, EPA and the Commonwealth had narrowed the options remaining for secondary or primary treatment from twenty-two to eight alternatives, but had not arrived at a statement of two preferred alternatives, one for secondary treatment and one for primary treatment. The most important factor leading to this outcome was a desire on the part of both EPA and the Commonwealth to encourage public scrutiny and obtain formal public comment on the results of initial screening process, the large amount of new data, the new decision criteria and the proposed mandatory mitigation before proceeding to suggest two preferred alternatives.

After the close of the SDEIS/EIR public comment period, in light of the high degree of public acceptance, EPA decided to retain criteria as a way to impose order on a mass of detail in this especially complex review, and to focus on those impacts which are relevant to the choice of a site. EPA also reviewed all the public comments submitted to identify both those criteria-relevant issues which needed futher analysis prior to selection of a preferred alternative and those other issues which related to the overall project or were otherwise not criteria-relevant, but which were appropriate for inclusion in the FEIS or the FEIR. EPA performed additional analyses on potentially site-relevent topics.

EPA and the MWRA agreed that it was appropriate for each to pursue an independent decision-making process under their respective statuatory mandates but to do so in parallel and with a high degree of coordination. Accordingly, to ensure that both agencies shared a common data base, as either agency identified data needs or developed information, it was shared with the other by exchange of technical memoranda and through technical presentations at meetings with EPA's Technical Advisory Group or with the MWRA's Board of Directors or staff.

EPA systematically reviewed its entire data base using the decision criteria and evaluated each piece of data in terms of one or more of the appropriate decision criteria. EPA felt that each decision criterion was legitimate and was confident that sufficient objective data existed to permit a reasoned judgement as to the acceptability of the alternative sites.

Mandatory Mitigation Measures

Upon the completion of the review of each decision criterion, the assumed level of mandatory mitigation as set forth in the SDEIS/EIR was either confirmed or, if appropriate, modified as the result of further technical information. EPA found that the most critical need for mitigation was to reduce impact on neighbors. EPA applied a set of specific mandatory mitigation measures to all alternative sites except as noted below. The mandatory mitigation measures can be summarized as follows:

. Barging of bulk materials to and from the site to reduce the amount of trucking through affected communities during construction;

. Use of a roll-on/roll-off barge loading facility at the site and at an onshore transfer station to accommodate heavy trucking;

. Busing and ferrying of construction workers to reduce commuter traffic in affected communities during the construction period;

. Use of "maximum feasible degree" of odor control and investigation of state-of-the-art odor control technology;

. A ban on the use of liquid chlorine at Deer Island unless there is "clear and convincing" need for it and proof that it can be handled without unnecessary risk to neighbors, including the prison workers and inmates;

. Implementation of noise control measures during construction, including the excavation of the Deer Island drumlin from the south side so that the remaining mass of the drumlin acts as a shield, and construction of a sound barrier at the Deer Island prison.

. Prohibition against trucking liquid chlorine to Deer Island as soon as piers and staging areas are available to commence over-water transport;

. Exploration of alternatives to the use of liquid chlorine at the treatment plant and at the associated headworks;

. Sampling of volatile organic compounds downwind from the existing primary plants at Deer and Nut Islands, exploration of technologies to control these compounds and installation of appropriate controls if necessry;

. Exploration of alternative treatment processes that might be less space demanding, less costly, or more reliable than secondary treatment based on the activated sludge process;

. Exploration of the feasibility of developing recreational uses of the site along with the treatment plant;

. Control of dust, erosion and sedimentation.

For a detailed statement of the mandatory mitigation measures, see pages 52-55 of the FEIS Volume I. Each of these mitigating efforts will be the subject of detailed study by the MWRA as further facilities planning explores these ways of achieving acceptable levels of impact. EPA, after appropriate environmental review, is prepared to modify these mitigation measures if equally effective protection can be achieved by other methods.

In the judgement of EPA, these stringent mandatory mitigation measures include all practicable means which are necessary and appropriate to avoid or minimize environmental harm from the alternative selected. EPA acknowledges that in some cases its mitigation package differs from the mitigation commitments described in the MWRA's FEIR and its findings under Section 61 of MEPA. EPA is confident, however, that its mandatory mitigation measures would result in an extraordinary degree of mitigation which would effectively minimize environmental harm.

Final Analysis*

During the final analysis, it became clear that three of the decision criteria, through theoretically important, no longer played site-distinguishing roles.

1. On "Cost", a more detailed analysis revealed that the costs of the four alternatives were so close that EPA decided to regard this decision criterion as having neutral effect.

2. On "Reliability", each of the sites permitted treatment plants of equal reliability.

3. On "Impact on Cultural and Natural Resources", though this decision criterion included federally protected resources (wetlands, barrier beaches, recognized historical and archeological sites, etc.), the impact of plants on either Deer or Long Island would be essentially equal and acceptable. On Nut Island, however, the Split Secondary Deer-Nut Alternative would involve the serious impacts of filling of tidal areas (unless homes were taken) and this was taken into account in the final decision.

Thus, "Effects on Neighbors", "Harbor Vision" and "Implementability" remained as the principal decision criteria for EPA. EPA felt each of these three criteria represented protection of important public values of substantial weight and each will be discussed below:

1. With respect to the "Effects on Neighbors" decision criterion, should the "no prison" variation of the All Secondary Deer Island alternative be implemented, EPA concluded that a treatment plant at either Deer Island or Long Island would have acceptable and essentially equal impacts on its neighbors, with the mandatory mitigation measures in place. However, if the prison were to remain on Deer Island, EPA concluded

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* In the following discussion it is important to note that, in the SDEIS/EIR, EPA and the Commonwealth concluded that under both Long Island alternatives, the Long Island hospital must be relocated off-island in order to avoid unacceptable impacts to "Effects on Neighbors", "Harbor Vision" and "Cultural and Natural Resources". EPA believes this conclusion remains valid.

that a plant site on Deer Island would have a greater effect on its neighbors than a site on Long Island, but these impacts as mitigated were acceptable. EPA felt that removal of the prison was desirable but not mandatory. EPA also concluded that the mandatory mitigation reduced the impacts so substantially that the plant could be constructed without unacceptable impact despite the presence of the airport and the prison.

The Split Secondary Deer-Long alternative would involve major construction activity of approximately the same perceived effect on the neighbors of each island as if the entire plant were being constructed there. Though those effects were found to be acceptable, it was felt to be unwise to impact two sets of neighbors unless there would be some benefit to another decision criterion; there was not.

Split Secondary Deer-Nut imposed severe burdens on its immediate neighbors on Hough's Neck without any corresponding benefit to Deer Island and Point Shirely. It was found to be environmentally unacceptable.

2. Considering only the "Harbor Vision" decision criterion, EPA concluded that though all four altenratives were acceptable, the All Secondary Deer alternative was preferred under "Harbor Vision". EPA believes that Deer Island's size, topography and setting give it acceptable long-term potential for rehabilitation as a park resource. However, because of Long Island's current potential as a major island park, EPA did conclude that while both All Secondary Deer and All Secondary Long satisfied the Harbor Vision decision criteria, All Secondary Deer satisfied it better.

Less acceptable were the other two alternatives. Though Split Secondary Deer-Long preserved significant potential recreation space at each island, EPA agreed with the Commonwealth that an entire island as park was preferable. Split Secondary Deer-Nut committed Nut Island to wastewater treatment without any corresponding benefit at Deer Island; though Nut Island has not been a major part of a harbor park plan, it could provide locally important open space.

3. Considering only the "Implementability" decision criterion, the following issues were of principal importance: permits and licenses, and the attitudes of the City of Boston and agencies and legislature of the Commonwealth. Even prior to the July 10, 1985, vote of the MWRA selecting All Secondary Deer Island as its tentative preferred alternative, EPA had concluded that the "Implementability" decision criterion pointed to All Secondary Deer with or without the prison because the principal remaining alternative, All Secondary Long (without the hospital), faced significant opposition. However, EPA was concerned that Deer Island prison removal was uncertain.

The July 10, 1985, and February, 1986 votes, and the MEPA Sec. 61 Findings of the MWRA, the proposing agency, which has the statutory authority to build the treatment plant and which controls much of Deer Island, confirmed EPA's conclusion that the All Secondary Deer alternative was clearly more implementable than any of the other alternatives.

The Governor's continued support of the MWRA, his renewed commitment to facilitate

relocation of the prison, and his new offer to identify a new prison site by May, 1986, further supports this result. Other officials have reiterated their support for prison removal if Deer Island is to be the site. As stated by the Secretary of Environmental Affairs in his Certificate on the FEIR, Janury 21, 1986:

> "...[T]hrough the joint struggle of all branches of government, the courts, the press, and the public, important milestones have now been passed - the creation of the Authority and public consensus on siting. A momentum has now built up, which I consider so powerful that the cleanup cannot and will not be stopped. The joint will of Mayor Flynn, Governor Dukakis, the General Court and our citizens is so strong that I am convinced the difficulties of prison relocation can be overcome...". (emphasis added)

EPA agrees with the MWRA that the reinforced support of relevant public officials for Deer Island prison removal and the continued opposition to Long Island Hospital removal makes prison removal "far more feasible" than hospital removal.

Furthermore, even if the prison were to remain, EPA notes the continued strong opposition of the city and state officials who control the future of Long Island to any use of Long Island as a treatment plant and notes their reiterated support for a Long Island park and for a continued role for the Long Island Hospital and Homeless Shelter.

Therefore, EPA confirms its previous judgement that All Secondary Deer Island (even if the prison were to remain) is more implementable than either of the other two environmentally acceptable alternatives: All Secondary Long and Split Secondary Deer-Long (both without the hospital).

In summary, with mandatory mitigation,

1. EPA found Split Deer-Nut to be environmentally unacceptable because of its severe impact on its "Neighbors" at Nut Island and on "Natural Resources", and strong barriers to "Implementability".

2. EPA found Split Deer-Long (without the hospital) to be environmentally acceptable; but EPA also found it to be undesirable because it spreads impacts on "Neighbors" and "Harbor Vision" to two islands without any benefit deemed valuable to a decision criterion. It also was unlikely to be "Implemented".

3. EPA found both All Secondary Long (without the hospital) and All Secondary Deer to have an acceptable impact on "Neighbors" and "Harbor Vision".
    a. "Neighbors". With mitigation, the impact of a Deer Island plant on its "Neighbors" is either equal to (without the prison) or worse than (with the prison) a Long Island plant.

b. "Harbor Vision". The impact of a Deer Island plant on the public benefits from and uses of Boston Harbor causes somewhat less harm than a Long Island plant.

c. "Implementability". Between these two acceptable and closely balanced alternatives, building a treatment plant on Deer Island (with or without the prison) is clearly more "Implementable" than building a Long Island Plant.

EPA's decision based on the foregoing analysis is that its preferred alternative is All Secondary Deer with mandatory mitigation. The FEIS contains more information on the decision process.

IV. IMPLEMENTATION, MONITORING, ENFORCEMENT OF MITIGATION MEASURES

Applicable regulations require EPA, in this ROD, to adopt and summarize an implementation, monitoring and enforcement program for its mitigation measures.

EPA's first implementation, monitoring and enforcement mechanism will be through the construction grants program. Section 201(g) of the Clean Water Act authorizes the Administrator to grant financial assistance to municipalities for the construction of municipal wastewater treatment plants. Section 511(c) of the Act states that the award of a construction grant may be considered a major federal action significantly affecting the quality of the human environment, subject to the requirements of NEPA. These statutes give EPA the authority to enforce the mandatory measures through the federal construction grants program. The mandatory mitigation measures for the selected site at Deer Island will be made necessary conditions of any Federal construction grants awarded to the MWRA during the Step 3 Construction Phase of this project.

EPA has determined, pursuant to Section IV B 7 of the 1984 Construction Grants Delegation Agreement and 40 CFR Section 3015(c), that an overriding federal interest exists in this project, in particular in regard to the implementation of the mandatory mitigation program specified in the FEIS. In order to ensure that all mandatory mitigation measures are implemented through the construction grants program, the agency will play a direct role in oversight of facilities planning, design and construction of the wastewater treatment plant including piers, outfalls and pipelines/tunnels. The specific role that EPA plans to play will be at least as follows:

. review all sections of all the facilities plans to ensure compliance with the mandatory mitigation program as set forth in FEIS Volume I, p.53-55.

. coordinate with the Massachusetts Department of Environmental Quality Engineering (DEQE), Division of Water Pollution Control in reviewing the plan of study for the facilities plans.

. participate in any technical and citizen advisory committees as part of the public participation program for the facilities plans.

. participate in the review of the draft products of the facilities plans, particularly the development of the mandatory mitigation measures.

. EPA will review at least the specfics of the proposed odor control program, noise control program and possible volatile organic compound emissions control program to ensure that MWRA is achieving effective impact reductions required by this ROD. On the issue of liquid chlorine use, EPA will ensure in its review of the facilities plan that MWRA has undertaken a thorough disinfectant alternatives analysis. On the issue of busing, ferrying and barging, EPA will monitor the development of the facilities planning investigations to ensure that MWRA establishes the required programs to mitigate transportation impacts.

. coordinate with DEQE for joint reveiw and approval of the final facilities plans. The facilities plans will be approved only upon successful development of the mitigation program as outlined in the FEIS.

. EPA will request the Army Corps of Engineers, during construction, to make periodic onsite reviews to ensure that the project is being managed properly, is on schedule, and is being constructed in accordance with approved construction drawings and specifications including mitigation measures and change orders.

In order to facilitate a high degree of review oversight by EPA, the agency intends to enter into an agreement with the DEQE Division of Water Pollution Control and MWRA to outline further details of EPA's oversight.

In addition to EPA oversight and participation in further facilities planning, EPA intends to assume primary responsibility for NEPA review by the preparation of any environmental assessments or supplemental EIS's determined to be necessary in connection with these activities. EPA and the Army Corps of Engineers plan to enter into a Memorandum of Understanding in order to minimize delays in any environmental reviews involving both agencies.

Second, the MWRA is under federal court order to initiate facilities plans for the shore-side piers and staging areas, on-site piers and staging areas, outfalls and tunnels or piplines. The MEPA unit of the Executive Office of Environmental Affairs has made the determination that EIR's will be prepared on these facilities plans. In addition, the facilities plans will include EID's which provide environmental evaluations of the final facilities plan components. EPA will conduct an independent environmental review, under NEPA, of these facilities plans, except for those aspects of the wastewater treatment plant covered by this EIS.

Third, in the unlikely event that federal funding for this project were to be totally unavailable due to the termination of the Construction Grants Program, this project will require other federal actions which bring it within NEPA. These include the transfer of surplus federal lands by the General Services Administration (GSA); permit actions by the Corps of Engineers for the construction of piers and the disposal of dredged material or fill; and possible permit actions by EPA for the ocean disposal of fill. Each of these actions triggers independent opportunities to implement and enforce the mitigation program. For example, GSA intends to dispose of the surplus property in accordance with the FEIS and has committed to incorporate the mandatory mitigation measures into its own Record of Decision as appropriate.

Fourth, this project is now the subject of a federal court action (United States of America v. Metropolitan District Commission, et al., Civil Action No. 85-0489 D.C. MA and a related case.) In the event of the cessation of the construction grants program, EPA will also consider seeking an order of the federal court mandating that the mitigation program laid out in the FEIS be implemented.

Fifth, it should also be noted that the MWRA has committed to the Commonwealth that it will undertake a set of mitigation measures which are, with the exception of prison removal, substantively equivalent to those required by EPA. These are contained in the Section 61 Findings of the MWRA to the Secretary of Environmental Affairs under the MEPA.

[See Section 3.2 Siting Decision, Subsection Final Selection in this Volume.]

FURTHER ENVIRONMENTAL REVIEW UNDER NEPA

EPA expects that further environmental review under NEPA relating to the cleanup of Boston Harbor will include appropriate study of the following phases of the process, including cumulative impacts:

1. Long-term residuals management, including the processing, transport and ultimate disposal of sludge. Scoping for this EIS has already commenced.

2. The construction of pier(s) and staging area(s) at the treatment plant site and on shore to allow for barging of bulk contruction materials, equipment, and work crews during construction, and possible transport of sludge. In the event that an existing pier cannot be located on the mainland, an additional pier or piers and staging area(s) would need to be constructed there.

3. The construction of an under-harbor tunnel or pipeline to transport wastewater to the treatment plant.

4. The water quality and construction impacts of an outfall pipe or pipes through which effluent will be discharged.

5. The possible disposal of earthen or dredge materials which might need to be removed from the site of the secondary treatment plant prior to construction.

6. The possible transport, handling, storage, and use of chlorine at the secondary treatment plant, depending upon the outcome of studies by MWRA regarding the environmental acceptability of its transport, handling, storage and use.

7. Combined sewer overflow projects.

CONCLUSION

EPA has engaged in a decision process which gathers technical information, exposed it to extensive public scrutiny, developed very stringent mitigation measures, and evaluated the alternatives in terms of disclosed decision criteria. EPA believes this open process has arrived at a fair and reasonable conclusion that the upgraded treatment plant, considered singly or in combination with other conditions, will be constructed and operated with acceptable environmental results.

3.3 RELATED PROJECTS

Projects

Although the Secondary Treatment Facilities Plan is the beginning of the key project in the Boston Harbor Cleanup Program, there is a long list of projects that are being planned, designed or are under construction to upgrade and expand the MWRA's wastewater collection and treatment capabilities. These projects are grouped into the following programs:

- Treatment Plant Upgrade
  - Nut Island Immediate Upgrade
  - Deer Island Fast Track Improvementss
- Interim Residuals Management
  - Interim Sludge Processing and Disposal
  - Interim Scum Management
- Long-Term Residuals Management
- Water Transportation Facilities
- Combined Sewer Overflows
- Harbor Research and Monitoring
- Wastewater Transport Program

In addition to the above wastewater programs, several waterworks projects have either a direct or an indirect bearing on the secondary treatment facilities planning. MWRA has also initiated several projects to strengthen its ability to direct and manage its extensive capital program and its extensive day-to-day operational responsibilities. The projects designed to strengthen

MWRA's institutional capability are described in Volume VII, Institutional Considerations. The related wastewater programs are described briefly in the following paragraphs.

Industrial Waste Program

In February of 1973, MWRA's Industrial Waste Program began to acquire data on all industries within the 43 cities and towns which comprise the sewerage district. This program has become the means whereby the Authority enforces Federal, State and MWRA regulations which govern the discharge of wastewater to the sewer system. The goals of the enforcement strategy are to decrease and control pollution loads to the treatment works; increase safety for maintenance and operational personnel; reduce illegal waste discharges such as extraneous water and septage from non-member municipalities; and prosecute for willful damage or vandalism.

The Industrial Waste Program, which was approved by the EPA in July of 1982, is being implemented in four phases: Inspections, Monitoring, Permitting and Enforcement.

Inspection Activities

The inspection program includes on-site inspection of all indusries in the district. It requires a discussion period with appropriate plant personnel to ascertain the type of activity being performed at the facility, the raw materials used, products and services produced, and the particular processes and unit operations employed. A tour of the facility is also conducted to verify the information received. Industries suspected of discharging a questionable waste are required to submit the results of laboratory analyses, performed on representative samples of the process waste by an independent laboratory, for review and evaluation by the Authority. The results of analyses, along with other pertinent information (permit application, inspection reports) on the industry, are used to determine whether or not the wastes are in compliance with the MWRA's Rules and Regulations. A permit application must be completed by all users discharging industrial wastes.

An intensified Industrial Inspection Program has commenced as a result of the increase in staff and resources. In Fiscal Year 1987, approximately 425 industrial inspections were conducted.

Septage Disposal Inspection Program

The Septage Disposal Inspection Program is basically divided into two activities: first is the oversight of the septage control activities of the member municipalities with septage receiving locations; and second is surveillance of each septage receiving location to determine compliance with MWRA Rules and Regulations and to identify any illegal septage dumping.

Each member municipality which operates or has designated a septage receiving station is responsible for the control and monitoring of all activities at the septage receiving location. The Water Quality Section evaluates control procedures at each septage receiving location for the purpose of determining the municipality's ability to control the dumping of septage from non-member communities, to prevent the discharge of industrial or toxic wastes, and to verify

the origin of all septage receiving at each septage receiving location.

In some instances the possibility of illegal or uncontrolled dumping at certain septage receiving locations is suspected. In response to these instances, surveillance of the septage receiving site is conducted in order to document septage disposal, and possibly identify illegal dumping activities requiring enforcement of dumping restrictions.

Identification of I/I and Surcharging During Routine Investigations

In adddition to identifying sources of toxic discharges to the sanitary sewer system, investigations at industrial facilities often identify the illegal discharge of "clean" water, also known as inflow. During these industrial investigations the most common form of inflow uncovered is non-contact, uncontaminated cooling water and non-contact, uncontaminated industrial process water.

In addition to identifying these and other sources of inflow, inspection personnel often identify excessive use of water and make recommendations to limit water use. These recommendations serve to reduce the flow in the already overloaded sewer system, which helps to minimize surcharging.

Monitoring Activities

The Monitoring Section of the Water Quality Department continually participates in a variety of activities, the most significant being monitoring for the Industrial Waste Pretreatment Program. More specialized areas of monitoring include sampling at the Treatment Plants, fulfilling NPDES Permit monitoring requirements, soil sampling, beach sampling, and verification of discharges and connections. Monitoring activities during Fiscal Year 1987 numbered 565, compared to 200 in Fiscal Year 1986.

Collection of industrial waste samples from industries discharging into the Authority Sewer System yields a profile of industrial wastes currently entering the system and provides the basis for enforcement to eliminate unacceptable concentrations of toxic and potentially harmful substances. The samples collected are forwarded to a laboratory for analysis, where strict Quality Assurance/Quality Control procedures are employed. Analytical results from this monitoring, in conjunction with information derived from inspecting and permitting activities, assist in determining the acceptability of the discharge and whether enforcement action is warranted.

The Monitoring Team has been involved in site assessment and the implementation of the monitoring program to fulfill the NPDES Permit requirements. The permit requires monitoring at Deer and Nut Island Treatment Plants and at three Combined Sewer Overflow (CSO) facilities (Cottage Farm Chlorination and Detention Station, Charles River Estuary CSO Treatment Facility, Somerville Marginal CSO Pretreatment Facility). At the treatment plants, samples are taken monthly for parameters not monitored daily by the plants, such as organics, metals and cyanide.

Beach sampling has been frequently requested in response to reports of odor problems and unidentified growths or discharges into the harbor.

Other monitoring activities include sampling soil or sludge to determine the degree of contamination to assist in proper disposal decisions, verification of discharges and connections via dye tests and researching sewer line maps, groundwater sampling, and sampling at construction or cleanup sites before discharge to the sanitary sewer system.

Municipal Permits/Sewer Use Discharge Permits

Sewer Use Discharge Permits are issued to each sewer user discharging industrial wastes located in the Authority Sewer District regardless of size, type or volume of discharge. For permitting purposes, the Sewerage Division has classified users into four categories according to the nature of their wastes. The categories are as follows:

1. Industries requiring pretreatment.
2. Industries having some toxic discharges but at concentrations which do not require pretreatment.
3. Industres which have non-toxic discharge in addition to sanitary flow.
4. Dry industries or industries with sanitary flow only.

Sewer Use Discharge Permits are revised as new information is received. At present, much of the activity involving permits is due to revisions and renewals, which are done on a daily basis.

Compliance and Enforcement

The Authority has been extremely successful in working with its Sewer Users in a cooperative spirit to eliminate existing or potential discharge problems, since the inception of the Industrial Waste Program. Over the years, thousands of industries and other sewer users have been inspected, monitored and issued permits. Through the inspection, monitoring and permit phases of the Water Quality Department's Industrial Waste Program, many of these industries were found to be in violation of acceptable discharge practices. Any continued violations of permit conditions or Sewer Use Rules and Regulations will result in enforcement actions to assure compliance with acceptable discharge practices. New Sewer Use Rules and Regulations promulgated May 1, 1987 have broadened the scope of MWRA enforcement powers, including rights to:

1. Issue an order to cease and desist any such discharge violations;

2. Direct a User to submit a detailed schedule, subject to such modifications as the Authority deems necessary, setting forth actions to be taken to correct or prevent a violation;

3. Issue an implementation schedule ordering specific actions and a time schedule;

4. Revoke, modify or deny a permit issued to the User by the Authority;

5. Impose administrative penalties up to $10,000 per day of continued violation, and seek payment for damages to its system pursuant to 360 CMR 10.105 and 360 CMR 2.00;

6. Bring a civil or criminal action as provided by law;/ or

7. Take any other action available to it under federal, state or local law or regulation.

In cases where significant resistance is given to the Authority's discharge regulations, enforcement actions have been initiated. Enforcement actions to date range from informal meetings with the offending companies to legal actions taken through the Office of the Attorney General of the Commonwealth of Massachusetts. The results have been civil penalties ranging upward of $600,000 and agreements for judgements mandating adherence to strict compliance schedules.

The Authority's newly promulgated Administrative Penalty Regulations and Rules for Adjudicatory Proceedings will enable the Water Quality Department to be more effective in enforcement. The Authority is also establishing firmer policy and procedures which will be followed for the imposition of Civil Penalties in those future cases which require the assessment of fines.

<u>Treatment Plant Upgrade Programs</u>

Both the existing Deer Island and Nut Island Treatment Plants are being upgraded to extend the useful life of the installed facilities until the new treatment facilities can be constructed and placed into operation.

The Nut Island Immediate Upgrade Project began in January, 1983 and is expected to be completed in May, 1988. Eight projects costing approximately $12 million have been initiated to extend the useful life of the Nut Island Plant approximately ten years. Table 3.3-1 summarizes the eight immediate upgrade projects. Table 3.3-1 also describes other projects that are planned or underway to rehabilitate the existing treatment plant.

The Deer Island Treatment Plant Fast Track Improvementss Program consists of several projects to raise the operating efficiency of the existing plant to an acceptable level. The construction of these upgrading projects started in June, 1986 and is expected to be completed in March, 1990. The Deer Island Fast Track Improvements Program is summarized in Table 3.3-2. Other projects that are expected to improve the service life of the existing facilities on Deer Island are also described in Table 3.3-2. These rehabilitation projects also include upgrading the remote headworks facilities which function as an integral part of the Deer Island Treatment Facilities.

TABLE 3.3-1
NUT ISLAND IMMEDIATE UPGRADE

o <u>Power</u>

- Rebuilding of one engine generator
- Installation of 2000 kw transformer for purchased off-site power to the site

o <u>Preliminary Treatment</u>

- Addition of influent flow meter (sonic type) on the High Level Sewer
- Installation of new ventilation system, odor control equipment, and explosion-proof electrical components to the grit facility
- Removal of comminutors downstream from the grit chambers
- Rebuilding of the effluent channels from the grit tanks
- Replacement of air header to the preaeration basins
- Rebuilding of one preaeration blower motor

o <u>Primary Sedimentation</u>

- Structural rebuilding of tanks and repairing of leaks
- Levelling of tank floors
- Replacement of all weirs
- Replacement of sludge collection equipment

o <u>Digesters</u>

- Replacement of outside sludge piping from the primary sludge pumps to the anaerobic digesters
- Digester roof rehabilitation

o <u>Outfalls</u>

- Installation of an automated sluice gate at the outfall
- Cleaning of the two main outfalls

o <u>Electrical Distribution Substation Replacement</u>

o <u>Sewerage Pump Switchgear Replacement</u>

TABLE 3.3-2

DEER ISLAND TREATMENT
FACILITY
FAST TRACK IMPROVEMENTS

- Pump Station and Power Station Improvements

  - 5 new 90 mgd influent sewage pumps
  - 4 new 2000 Hp electric motors
  - New graphic control center to monitor sewage flow
  - New cooling water system for engines
  - New pumps for process water building
  - New heating system process water building
  - 2 new 6000 kw dual fuel, engine/generator sets
  - New switch gear/electrical distribution center
  - New fuel storage system for engines

- Rehabilitation of Digesters
  - 4 new floating roofs
  - New internal digester piping
  - New gas meters at each digester
  - New waste gas burners with meters
  - 6 new spiral heat exchangers
  - 4 new sludge hot water pumps
  - 1 new boiler
  - Rehabilitation of 2 Ingersoll-Rand gas compressors
  - A new heating and ventilating system for both the sludge thickener and the digester complexes
  - A gas detection system for both complexes

- Sludge Thickener Improvements

  - Remove existing tank mechanisms
  - Remove existing bridges, pumps and associated piping
  - Install new thickener mechanisms and bridges
  - Install new sludge transfer system, pumps and compressors
  - Install associated piping, electrical and control instrumentation

- Primary Sedimentation Basins Improvements

  - New grit collection system
  - New grit classification building
  - New scum concentration building

Table 3.3-2 (cont'd)

- New chemical feed building
- Influent and effluent sampling stations
- 80 new motorized influent sluice gates and 80 stainless steel baffles
- New flow splitter plate, to equalize grit distribution
- Structural repairs to the sedimentation basins and bridges
- 48 new stainless steel aeration leaders and diffusers
- 3 new air compressors for the aeration channels

o Chlorine Rehabilitation

- 8 new evaporators
- 8 new chlorinators
- 2 new scale systems
- New HVAC system
- New roof
- New piping and distribution system for chlorine and process water

o Electrical Upgrade

- 4 new electrical distribution substations
- New conduit for substations
- New motor control centers throughout Deer Island

o Dual Fuel/Generator Overhaul

- Overhaul of 5 diesel enginers 1000 Hp
- Overhaul of 4-700 kw generators

o Deer Island Remote Headworks Improvements
(Columbus Park, Chelsea Creek and Ward Street)

- New grit collection and removal equipment for all 12 channels (four at each facility)
- New climber-type mechanical screens
- New HVAC equipment
- New odor control equipment
- Improvements to electrical systems
- Monorails, hoists and bridge cranes
- Hydraulic power units for sluice gates

o Winthrop Terminal Headworks Improvements

- Three climber-type mechanically cleaned bar screens
- Grit collection equipment

Table 3.3-2 (cont'd)

- Three inlet sluice gate operators and hydraulic power system
- Overhaul six sewage pumps (4-16,00 gpm and 2-32,000 gpm)
- Six new drive motors and controls
- Screening discharge enclosure
- Two stair access/egress towers

Interim Residuals Management Program

The Interim Residuals Management Program is intended to provide the facilities necessary to cease the discharge of sludge to the ocean by 1991. MWRA is presently soliciting proposals from private firms to provide land based disposal of sludge until the long term management facilities now being planned are constructed in 1995. The Interim Residuals Management Program includes sludge from both the Deer Island and the Nut Island Treatment Plants.

A second component of the Interim Residuals Management Plan is interim scum management. Scum is the floatable material that is skimmed from the surface of sedimentation facilities at both treatment plants. Scum is currently mixed with the sludge and discharged to the harbor. Because these materials are the more obnoxious and visible discharged to the harbor, the removal of these materials has been given the highest of priorities. For the interim period at Nut Island, scum screening, chemical conditioning and landfill disposal was selected as the recommended scum handling option. Design of these facilities was initiated in May, 1987. At Deer Island, the recommended plan for termination of scum discharges involves a one year demonstration project. This project includes chemical fixation of all Deer Island scum by a private contractor with storage on-island. Initiation of this period is anticipated in November, 1987. At the end of the one year demonstration, a decision will be made to build permanent facilities or to continue with a service contract.

A third component of the interim residuals management plan is a composting pilot plant. Composting stabilizes organic materials and destroys bacteria and viruses in sludge. Composted sludge has the potential for use as a soil supplement for production of turf grass, horticultural uses at green houses, use as a low-grade fertilizer or use as a landfill cover material. The pilot plant was initiated in 1984 and currently processes fifteen dry tons per day of sludge. The pilot plant serves the dual purpose of reducing the quantity of sludge discharged to the harbor and at the same time provides a compost product to test and develop a market for the material in the greater Boston area. The compost pilot also provides valuable information for the assessment of the viability of composting as a long-term residuals management option.

Long-Term Residuals Management Facilities Plan

The facilities planning for the long term management of residual solids is being conducted concurrently with this planning effort. The planning effort includes assessment of the quantity and quality of Deer Island and Nut Island sludge, survey of available sludge processing and transport technologies, selection of appropriate technologies, screening of potential disposal sites and selection of optimum facilities and sites. Design and construction will include both on-island and mainland facilities. The facilities planning is scheduled for completion in 1988. Figure 3.3-1 illustrates the general flow of planning activities for the residuals management facilities plan.

Water Transportation Facilities

The Water Transportation Program includes the construction of the piers and related facilities to move materials, workers and equipment to and from Deer Island for the construction of the new treatment facilities and at Nut Island to support construction of the new headworks facility. Facilities planning for both on-island and on-shore piers is essentially complete. On-island piers are now being designed. Construction of these essential facilities is expected to commence in March, 1988 and be completed in September, 1989. Construction of the on-shore piers is expected to start in September, 1988 and be completed in May, 1990. See Figure 3.3-2 for a schedule of water transportation facilities planning.

Combined Sewer Overflow Program

MWRA is currently evaluating a means of abating pollution from combined sewer overflows. Figure 3.3-3 denotes the overall facilities planning for the CSO program.

Harbor Research and Monitoring

The ultimate goal of this project is the design and implementation of a plan for action directed towards cleaning up Boston Harbor and protecting the Harbor in the future.

A Technical Advisory Group (TAG), established in 1986, produced a "Study Plan for Basinwide Management of the Boston Harbor/Massachusetts Bay Ecosystem". This plan defined the goals for research and monitoring in Boston Harbor and Massachusetts Bay that will be closely tied to management issues. The study plan further identified many issues facing environmental managers. Of these issues, five have been identified as high priority, requiring a well-focused scientific study.

Wastewater Transport Program

MWRA member communities discharge their wastewater through 1825 connections and 5400 miles of local sewers to 228 miles of MWRA sewers and 10 MWRA pump stations. In 1976, the EMMA study recommended approximately $1.7 billion in improvements to sewers through the year 2000. Since 1976, the sewer relief program has informally taken on a definition involving four major projects:

Braintree-Weymouth Relief Sewer
New Neponset Valley Relief Sewer
Framingham Extension Relief Sewer
Wellesley Extension Relief Sewer

Progress has been slow on the four major projects due to the complex and controversial nature of each project. The MWRA has, however, demonstrated success with the following projects either under consruction or completed:

Millbrook Valley Relief Sewer
Reading Pumping Station
Reading Extension Sewer
East Boston Pump Station
Hingham Force Main

The Water Transport Program is moving forward, with the potential downstream impacts of the utmost concern. The Southern System Modeling Project, which is now underway, is the first major step in this process.

MWRA plans to participate in a joint public and private effort to establish a Harbor monitoring and research program. The program will conduct research that will report on existing conditions and measure incremental change as the residuals management program and treatment plant upgrading are implemented. The priority areas to be studied include: (1) sources and fate of contaminants; (2) effects of contaminants and the health of the living resources; (3) nutrient enrichment; (4) economic, legal, political and social science assessment and; (5) public health impact. The study of these areas requires both short term projects designed to answer particular questions and a monitoring program that will determine long term impacts of human activities on the marine ecosystem. The technical results produced by these studies should be used in multiple-use management endeavors conducted by several agencies.

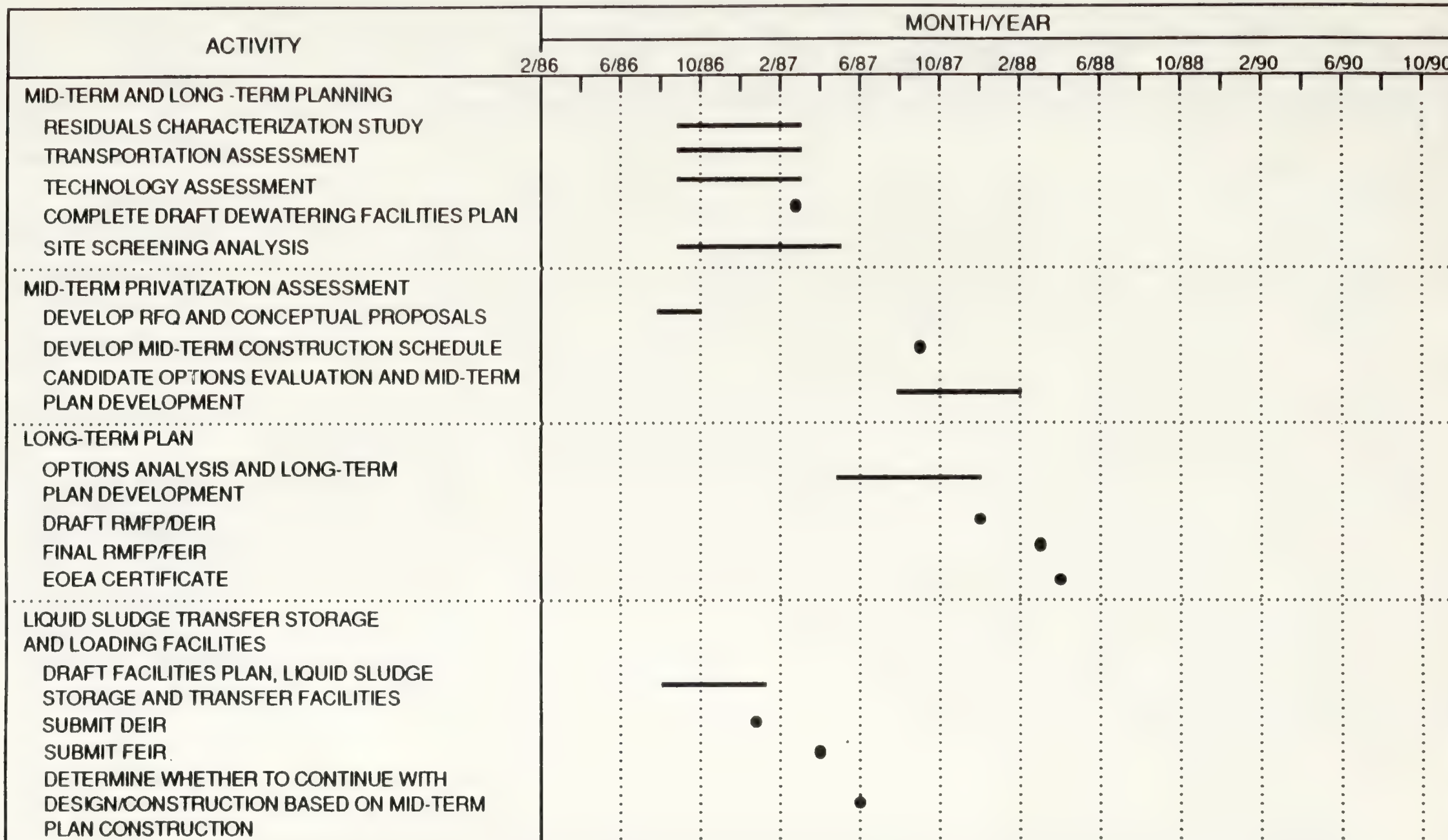
3.4 PROJECT MILESTONES

Though pollution of Boston Harbor has been a matter of public concern since the late 1960's, awareness was heightened in December of 1982 when the City of Quincy filed a lawsuit against the Metropolitan District Commission and the Boston Water and Sewer Commission (BWSC). Quincy sought relief from the pollution of Quincy Bay, which it claimed was resulting from the discharges of untreated and partially treated sewage from Nut Island and Moon Island.

As a result of this suit and the recommendations of the court-appointed special master, a bill was filed to remove sewer responsibilities from the MDC and to place them in a financially and organizationally independent public authority. On December 19, 1984, the Massachusetts Water Resources Authority was created.

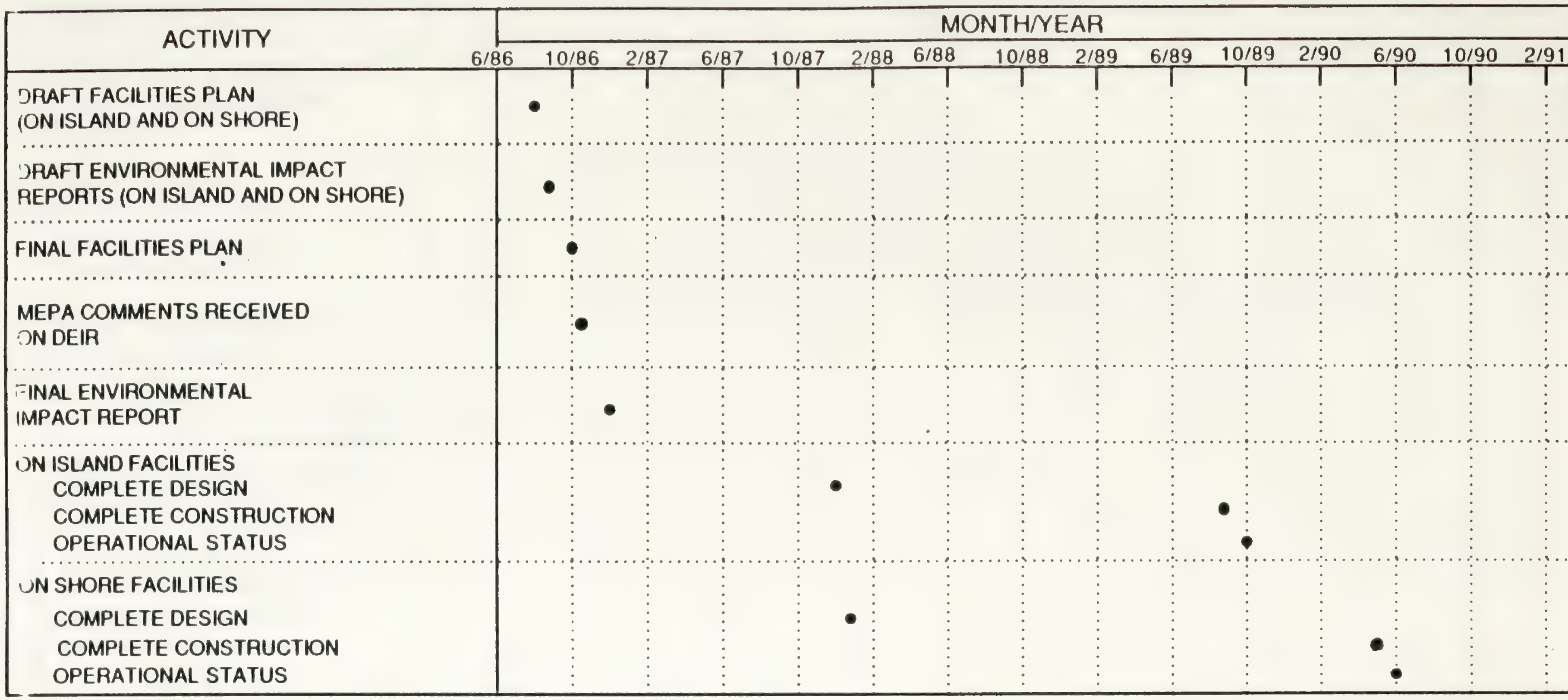
On the following day, the EPA announced its intention to take additional action to help secure a harbor cleanup and brought suit in federal court, requesting a set of deadlines for pollution control projects. Filed at the end of January, 1985, the suit named four defendants: the MDC, the MWRA the state and the BWSC.

As a result of this lawsuit, on May 8, 1986 the United States District Court of Massachusetts imposed "major milestones" as long-term target dates to assist facilities planners toward the completion of primary and secondary treatment facilities. These dates are as follows, with milestone dates relating to this facilities plan in bold type:



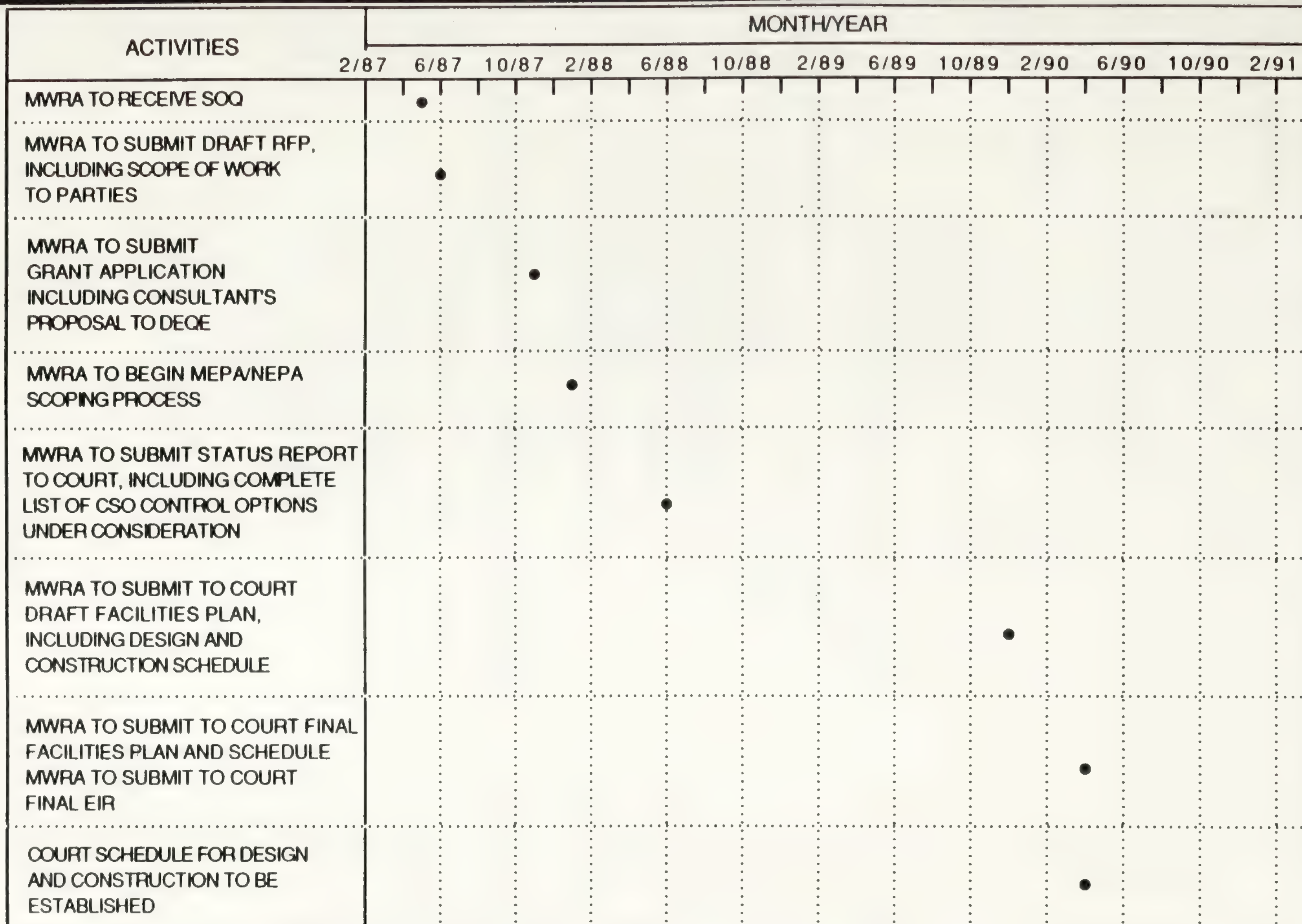
MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 3.3-1 RESIDUALS MANAGEMENT PROJECT SCHEDULE



MASSACHUSETTS
WATER RESOURCES
AUTHORITY

FIGURE 3.3-2
WATER TRANSPORTATION FACILITIES
PROJECT SCHEDULE



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 3.3-3
COMBINED SEWER OVERFLOWS PROJECT SCHEDULE

Design and Construction of Piers and Staging Areas and Facilities Planning

On-Island

a. Complete Design	12/87
b. Bid Construction	5/88
c. Award Construction	8/88
d. Complete Construction	9/89
e. Attain Operational Status	10/89

On-Shore

a. Complete Design	1/88
b. Bid Construction	6/88
c. Award Construction	9/88
d. Complete Construction	5/90
e. Attain Operational Status	6/90

Facilities Planning

a. Project Start	**5/86**
b. File ENF (s)	**6/86**
c. Complete Draft Facilities Plan	**9/87**
d. Complete Draft EIR	**10/87**
e. Complete Final Facilities Plan	**12/87**
f. Complete FEIR	**2/88**
g. Complete Environmental Review	**4/88**
h. Accept Facilities Plan	**5/88**

Construction of Treatment Plant, Outfall and Inter-Island Wastewater Conveyance System

a. Initiate construction of new primary treatment facilities	12/90
b. Complete construction and commence operation of new primary treatment facilities	7/95
c. Initiate construction of outfall	7/91
d. Complete construction of outfall	7/94
e. Initiate construction of inter-island wastewater conveyance	4/91
f. Complete construction of inter-island wastewater conveyance	12/94
g. Initiate construction of secondary treatment facilities	during 1995

Section 4

4.0 BASIC PLANNING CRITERIA

4.1 PLANNING PERIOD

The planning period used in this facilities plan encompasses the period from now through the year 2020. This represents the first 20 years of operation of the secondary plant, which has been targeted by the federal court to be in operation not later than the end of 1999. The use of 20-year planning periods is considered generally accepted practice in the profession and is required by facilities planning regulations issued by the U.S. Environmental Protection Agency (EPA).

4.2 SERVICE AREA

Under its enabling legislation, MWRA is charged with providing treatment to the wastewaters generated in 43 municipalities and special districts. The legislation permits permanent sewer service to other communities, but only after these communities have shown that no feasible alternatives exist, and after numerous regulatory and legislative approvals have been obtained.

Expansion of the service area, if it takes place, will occur at the boundaries of the existing service area. Figure 4.2-1 shows the existing service area, together with communities adjacent to the boundary of the area. The figure also shows the extent to which existing wastewater generated in the adjacent communities is treated by others. As can be seen from the figure, most communities abutting MWRA's service area are already served by a wastewater system. Any system expansion that might be considered would be on a very limited basis due to existing wastewater utilities on the perimeter of the MWRA service area. Therefore, in developing population and flow projections described in Volume II, the existing service area was used as a base.

Currently, MWRA owns and operates two wastewater treatment plants, one at Deer Island and the other at Nut Island, which handle wastes from the northern and southern member municipalities, respectively. As indicated, some communities in the service area are serviced by both plants.

The southern system encompasses an area of 236.83 square miles and currently has a total population of 745,917 and a contributing population of 629,553. Five MWRA pumping stations are located throughout the south system contributing area.

The Nut Island facility, which services the south system, currently serves 21 communities:

Ashland	Hingham (north sewer dist.)	Quincy
Boston (part)	Holbrook	Randolph
Braintree	Milton (part)	Stoughton
Brookline (part)	Natick	Walpole
Canton	Needham	Wellesley
Dedham	Newton (part)	Westwood
Framingham	Norwood	Weymouth

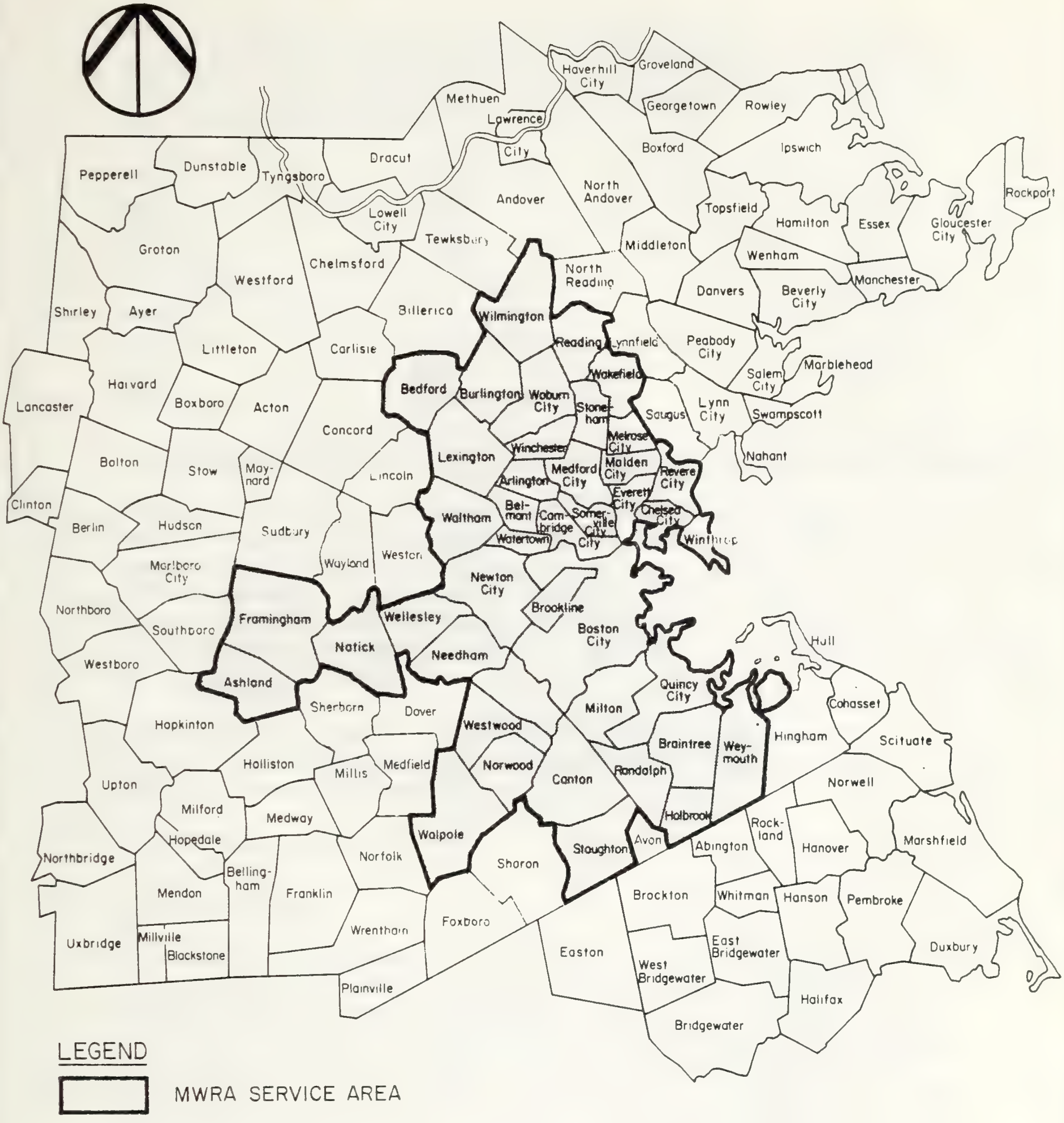


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FIGURE 4.2-1
MWRA SERVICE AREA

The Deer Island facility serves 26 communities. The area served by this treatment plant is 168.03 square miles with a total population of 1,300,520 and a contributing population of 1,248,472. Six MWRA pumping stations are located throughout the north system contributing area. Member cities and towns include:

Arlington	Lexington	Stoneham
Bedford	Malden	Wakefield
Belmont	Medford	Waltham
Boston (part)	Melrose	Watertown
Brookline (part)	Milton (part)	Wilmington
Burlington	Newton (part)	Winchester
Cambridge	Reading	Winthrop
Chelsea	Revere	Woburn
Everett	Somerville	

4.3 CRITERIA FOR EVALUATION OF INTER-ISLAND TRANSPORT SYSTEM ALTERNATIVES

The purpose of this section is to describe the criteria that will be used to evaluate inter-island transport system alternatives. The description of the criteria will enable the reader to understand how a particular criterion is used to rate an alternative. Each alternative considered is compared with the evaluation criteria. The evaluation presents sufficient information about each alternative in both summary and narrative form so that informed decisions can be made in selecting the recommended plan. The MWRA Board of Directors will select the recommended plan.

The following sections describe the specific evaluation criteria used in the detailed evaluation of inter-island transport system alternatives presented in Section 7.0. (The criteria are summarized in Table 4.3-1.)

4.3.1 ENVIRONMENTAL

Air Emissions Control

Air emissions control is the potential for generating odor/air emissions and therefore, indirectly, is an indication of the level of control necessary to limit air emissions from wastewater treatment, transport, and site preparation activities. The relationship among emissions of volatile organic compounds (VOCs), ambient air toxic levels, and concentrations at sensitive receptors, as well as the effects of VOC emissions on the National Ambient Air Quality Standards (NAAQS), are evaluated using an EPA-approved computer model. Estimates are made for each source (i.e., treatment process unit) to obtain total air emissions during plant operation for each individual chemical of interest. An analysis is performed to determine a control technology with the lowest achievable emission rate (LAER) and the best available control technology (BACT).

TABLE 4.3-1
SECONDARY TREATMENT FACILITIES PLAN
PROPOSED CRITERIA FOR DETAILED EVALUATION OF INTER-ISLAND TRANSPORT SYSTEM ALTERNATIVES

CRITERIA	INDICATORS
ENVIRONMENTAL	
Air emission control	See text.
Noise control	Difficult, modest, minimal
Environmental criteria	Significant, modest, minimal
Traffic	Number of trips
TECHNICAL	
Area requirements	Acres or square feet
Reliability	Acceptable, high
Flexibility	Low, medium, high
Constructibility	Aggravated, modest, minimal
Quantity and quality of spoils	Cubic yards
INSTITUTIONAL	
Timely implementation	Difficult, modest
Permitting	Extensive, modest
External coordination requirements	Extensive, modest, minimal
Internal coordination requirements	Extensive, modest, minimal
Demand for unique or scarce construction resources	Difficult, moderate
Flexibility to meet project phasing	None, fair, good
COST	
Present worth costs	Millions of dollars
Project costs	Millions of dollars
Annual operation and maintenance costs	Millions of dollars per year

Noise Control

MWRA is committed to complying with stringent noise mitigation and developing a program to avoid adverse noise impacts during construction and operation. For each project alternative (i.e., treatment process unit), an estimate of the noise level during operation, expressed as dBA, is presented. Resulting attenuated noise levels at various distances from the noise source are estimated. These estimates take into account mitigation measures such as earthern berms and building enclosures for major equipment. Noise during construction is also considered. In the screening of alternatives, the comparison is based on the ease of controlling noise since all alternatives meet the mitigation commitments. Wastewater project component alternatives rated "difficult" have a potential for high noise levels and require a greater level of control. An alternative rated "modest" produces noise and requires noise

control mitigation to about the same degree as typical wastewater transport and treatment facilities or typical site preparation projects. Alternatives rated "minimal" require little or no noise control.

Environmental Criteria

These criteria measure a project component's effect on selected environmental items during construction and, if applicable, during operation. The following list is based on EPA guidelines for facilities planning. Each alternative will be evaluated (where applicable) for impacts on:

- Historical and archaeological sites
- Floodplains, wetlands, and barrier beaches
- Fish, shellfish, and other marine biota
- Wildlife and endangered species
- Recreational opportunities

Alternatives are rated as having "minimal," "modest," or "significant" effects.

Traffic

MWRA is committed to limiting traffic through Winthrop during construction and operation of the treatment facilities. For each alternative, the number of truck trips and barge trips for personnel, materials, and equipment during construction are estimated. Estimates are also made for the number and type of trips required during operation.

4.3.2 TECHNICAL

Area Requirements

Area requirements for permanent structures located above grade are estimated for each alternative. Area is calculated in acres or square feet.

Reliability

Reliability is the level of assurance that the inter-island wastewater transport system will continuously operate over the expected range of operating conditions throughout the life of the project. Reliability is a criterion in selecting and arranging active components of the system, such as electrical and mechanical equipment. Reliability is not a criterion in selecting and arranging passive components of the system, such as structures, buried pipelines, and tunnels.

The reliability of pumping station equipment alternatives are rated using two levels: "acceptable" and "high." Alternatives ranked "high" are expected to operate continuously without system impact. Alternatives ranked "acceptable" can be expected to have infrequent equipment outages. In all cases, back-up pumping capacity will be available from standby

units. Also, two separate sources of electric power will be provided to the pump motors.

Flexibility

Flexibility is the degree to which a hydraulic transport system alternative will accommodate peak wastewater flows or a significant, generally unanticipated equipment failure. An upset condition is one that is other than normal, but anticipated. For this study, alternatives are rated using one of three levels of flexibility: "low," "medium," and "high." Alternatives ranked "high" are not significantly affected by upset conditions. Alternatives ranked "medium" or "low" are sometimes affected by these conditions but will meet standards.

Flexibility, like reliability, is applicable to active components, but not conduits.

Constructibility

Constructibility is the level of assurance that the inter-island transport system will be constructed on schedule. Constructibility is used to evaluate the transport conduit alternatives: (1) buried marine pipeline or sunkentube and (2) deep rock tunnels. This criterion includes availability of labor skills, equipment, and materials; proven, as opposed to state-of-the-art, construction methods; and the impact of adverse weather. Alternatives are described as having "minimal," "modest," or "aggravated" conditions for construction.

Quantity and Quality of Spoils for Disposal and/or Relocation

Construction of the inter-island wastewater transport system will require the removal and disposal of excavated materials from tunneling and/or dredging. For this study, the total volume of spoils (cubic yards) requiring disposal and/or relocation for either method is presented for each alternative. In addition, material that will require offsite disposal is assessed as to the type and quality of material and the difficulty expected in ultimately disposing of the material.

4.3.3 INSTITUTIONAL

Timely Implementation

Timely implementation is the relative difficulty expected in maintaining the schedule for installation and/or expansion of the system in discrete, manageable components. For this study, two ratings are appropriate for this criterion: "modest" and "difficult." For alternatives with features likely to make implementation difficult or to cause project delays, the "difficult" rating is used. For alternatives with fewer challenges, the "moderate" rating is used.

Permitting

Permitting is the relative difficulty in obtaining the necessary permits for an alternative. Alternatives are rated "minimal" "modest," or "extensive" to reflect the relative time required

to obtain a permit.

External Coordination Requirements

External coordination requirements measure the relative degree to which MWRA must interact with outside organizations to achieve the desired objectives. This includes consideration of legislative approval and other requirements necessitated by legal and jurisdictional limits to MWRA's authority. Alternatives are rated "minimal," "modest," or "extensive," depending on the degree of coordination required.

Internal Coodination Requirements

Internal coordination requirements measure the relative degree of coordination required between MWRA projects or programs, such as the coordination required between the wastewater treatment section and the industrial waste section. Alternatives are rated "minimal," "modest," or "extensive," depending on the degree of coordination required.

Demand for Unique or Scarce Construction Resources

This criterion is a measure of the demand that any one alternative may put on resources that are in scarce supply or not available in the local area. Key shortages of some labor skills and equipment may occur because of the concurrent construction of major projects such as the third harbor tunnel. Alternatives are rated "moderate" if potential conflicts exist, "difficult" if demands clearly exceed supply.

Flexibility to Meet Project Phasing

This criterion evaluates the site development alternatives according to the relative ease with which they could facilitate phasing of the primary or secondary plant with the goal of expediting the overall construction schedule. The degree of flexibility is assessed as "none," "fair," or "good."

4.3.4 COST

Present Worth Costs

Present worth costs are the sum of those costs required to construct and operate the project. They are presented in the form of a single initial investment that, according to EPA guidelines, is equivalent to the costs of constructing facilities and paying for annual operating costs during the planning period. The design year of the project is 2020, 20 years after the planned startup of the secondary treatment facilities and 25 years after the planned startup of the new primary treatment facilities. Present worth costs for each project component alternative is presented in terms of millions of dollars.

Project Costs

Project costs of alternatives include capital costs to construct facilities, costs for equipment replacement during the planning period, and 35 percent to cover construction contingencies and administrative, engineering, and legal costs. Any significant and special mitigation costs are included in the alternative costs. Construction costs of necessary facilities in this plan do not include costs for land purchase, since these costs are common to all alternatives. Financing, legal, and administrative costs to implement the project are presented only for the recommended plan. Project costs are presented in terms of millions of dollars.

Annual Operation and Maintenance Costs

Operating costs include power, labor, and utility costs and the cost of supplies. Power costs include consideration of power company demand charges and credit for power produced onsite. Labor costs are based on average salary levels, including employee benefits. Annual operation and maintenance costs are presented in terms of millions of dollars per year.

4.4 GUIDELINES FOR COST EVALUATION

To use cost-effectiveness comparisons of the treatment alternatives considered for detailed analysis, guidelines for unit process cost evaluation and procedures for determining life-cycle costs have been developed. Common parameters used in all cost-effectiveness comparisons include design lives, discount rate, salvage values, and base year for analysis.

Life-cycle cost factors have been prepared for the inter-island transport system, outfall project, design and construction of the primary treatment facilities, and the design and construction of the secondary treatment facilities due to the phased construction.

4.4.1 DISCOUNT RATE

At the start of each fiscal year, EPA establishes the discount rate to be used for life-cycle cost analyses. The rate used for this analysis is 8-5/8 percent, the rate established by the Water Resources Council as of 1 October 1985.

Several of the events on the life-cycle cost diagram do not occur at one-year intervals. Because of this, the life-cycle cost analysis factors generated for the facilities planning have been developed using a monthly discount rate of 0.71875 percent (8-5/8 percent divided by 12), and payments have been divided into monthly periods.

4.4.2 BASE YEAR AND PLANNING PERIOD FOR ANALYSIS

The base month selected for the cost analysis is January 1990. The year 1990 represents the first year of projected construction activity for primary treatment facilities. Although the projected start-up for construction is not until July of that year, it was considered much easier to use the beginning of the year as a base.

The end of the life cycle of the project will be January 2020. This provides for 20 years of operation of the completed secondary treatment facilities.

4.4.3 CONSTRUCTION COST INDEX

The construction costs used for the project are based on estimates of September 1986 prices. The construction cost index presented in the Engineering News Record (ENR-CCI) for September 1986 is 4332.5. To simplify, 4330 is used for the baseline cost index.

4.4.4 COST ESCALATION FACTORS FOR ENERGY USE AND WASTEWATER FLOW INCREASES

There is no escalation of energy or chemical costs for the purposes of the cost-effectiveness comparisons. Cost escalation for energy and chemicals are considered a part of a sensitivity analysis. Different rates are used to determine potential impacts on total present worth costs of the relative ranks of alternatives. None of the costs are weighted according to flow. It is unlikely that one alternative would have an appreciably higher flow-dependent cost than another. In addition, the average flow in 1986 is approximately 93 percent of the ultimate average flow. This difference in flow is not enough to warrant a difference in number of staff. The difference in energy and chemical requirements would not be appreciable.

4.4.5 METHODOLOGY FOR EVALUATION OF INNOVATIVE AND ALTERNATIVE COST PREFERENCE

As outlined in current EPA regulations (40 CFR35 Subpart E, Appendixes A and E), a cost-effectiveness preference should be given to innovative and alternative processes and techniques. The criteria set forth in that regulation determine whether wastewater treatment processes and techniques are innovative. If the present worth cost of an innovative or alternative treatment work is not more than 115 percent of the present worth cost of the most cost-effective alternative pollution control system, that option is considered.

4.4.6 LIFE EXPECTANCIES

The life expectancies of cost items are important in determining future replacement costs and salvage values at the end of the project period. The life expectancies used for these projects are 5 years for vehicles, 15 years for all equipment, and 50 years for buildings, structures, tunnels, and pipelines.

4.4.7 LAND COSTS

The cost of land is not expected to be a part of the life-cycle cost analysis. All land necessary for the new wastewater treatment facilities is or will be owned by MWRA. Also, in accordance with the cost-effectiveness guidelines, the land values must be salvaged at the end of the planning period. Therefore, they would be negligible in the final cost-effectiveness comparison. Thus, there is no need to consider land costs in the life-cycle cost analysis.

4.4.8 PROJECT COSTS

The term "project cost," used throughout the discussion of cost factors, consists of the estimated capital construction cost plus the cost of engineering and contingencies. The sum of engineering and contingency costs is estimated to be 35 percent of the installed cost; in other words, estimated installed cost of an item multiplied by a factor of 1.35 yields the project cost.

4.4.9 INTEREST DURING CONSTRUCTION

Interest during construction was calculated based on the following:

- Uniform cash flow over construction period (therefore, constant gradient of interest payments)

- Discount rate of 8-5/8 percent per year

- Monthly payments of interest due

- No investment dividends on borrowed money not yet paid on the project

- Gradient series of interest payments converted to annual and then present worth costs

4.4.10 ANNUAL COSTS

Annual costs are those costs paid each year to keep the facilities in good operating order and to preserve the lives of structures and equipment. The following items, among others, are included:

- Wages and salaries

- Maintenance items

- Energy consumption

4.4.11 BASIS OF COST COMPARISONS

All cost comparisons are made in terms of present worth costs instead of equivalent annual costs. This has been done to avoid confusion with annual operating and maintenance costs. Relative rankings of alternatives will not change whether present worth or equivalent annual cost is the method of comparison.

Tables of cost factors have been prepared with both 1990 and the start-up dates of the individual items as base years. Present worth factors at start-up dates have been prepared because translating future costs to present worth makes them appear deceptively low.

Section 5

5.0 EXISTING CONDITIONS

5.1 EXISTING FACILITIES

The inter-island transport system is required to hydraulically link Nut Island with Deer Island. Its purpose will be to convey the wastewater currently being treated at Nut Island to the new secondary treatment plant to be constructed on Deer Island.

Sections 5.1.1 and 5.1.2 generally describe the existing collection, treatment, and outfall systems at Deer Island and Nut Island.

5.1.1 DEER ISLAND TREATMENT PLANT

The Deer Island Wastewater Treatment Plant, originally completed in 1968, provides primary treatment to flows from the North Metropolitan Sewerage System. The plant was designed to treat an average flow of 343 million gallons a day (mgd), and a peak flow of 848 mgd. Treatment consists of preparation, primary sedimentation, and disinfection.

Flows from the Boston Main Drainage Tunnel and the North Metropolitan Relief Tunnel are pumped to the treatment plant by the Deer Island Main Pumping Station. Flows from the North Metropolitan Trunk Sewer are discharged to the plant via the Winthrop Terminal Headworks. Mixed flows are pumped to preparation channels. Primary treatment is provided by eight sedimentation tanks. Effluent from the primary tanks is chlorinated and discharged to the harbor through a series of outfalls.

Primary sludge, grease, and scum are collected, thickened, and pumped to anaerobic digesters. Digested sludge and bypass flows from the Winthrop Terminal are mixed with primary effluent prior to discharge to the harbor.

Major Components

The major components of the original Deer Island Wastewater Treatment Plant include the following:

- o Nine main sewage pumps, 90 mgd each
- o Two preaeration channels, 400 ft by 20 ft
- o Eight primary sedimentation tanks, 245 ft by 100 ft
- o Four raw-sludge pumping stations with three pumps in each
- o Four anaerobic digester tanks
- o Five diesel generating sets, 700 kW each
- o Seven chlorinators, 8,000 lb/day each
- o Five outfalls to the harbor

Schematics of the Deer Island Wastewater Treatment Plant showing the flow pattern, the number and arrangement of treatment units, and the outfall system are presented in Figure 5.1.1-1.

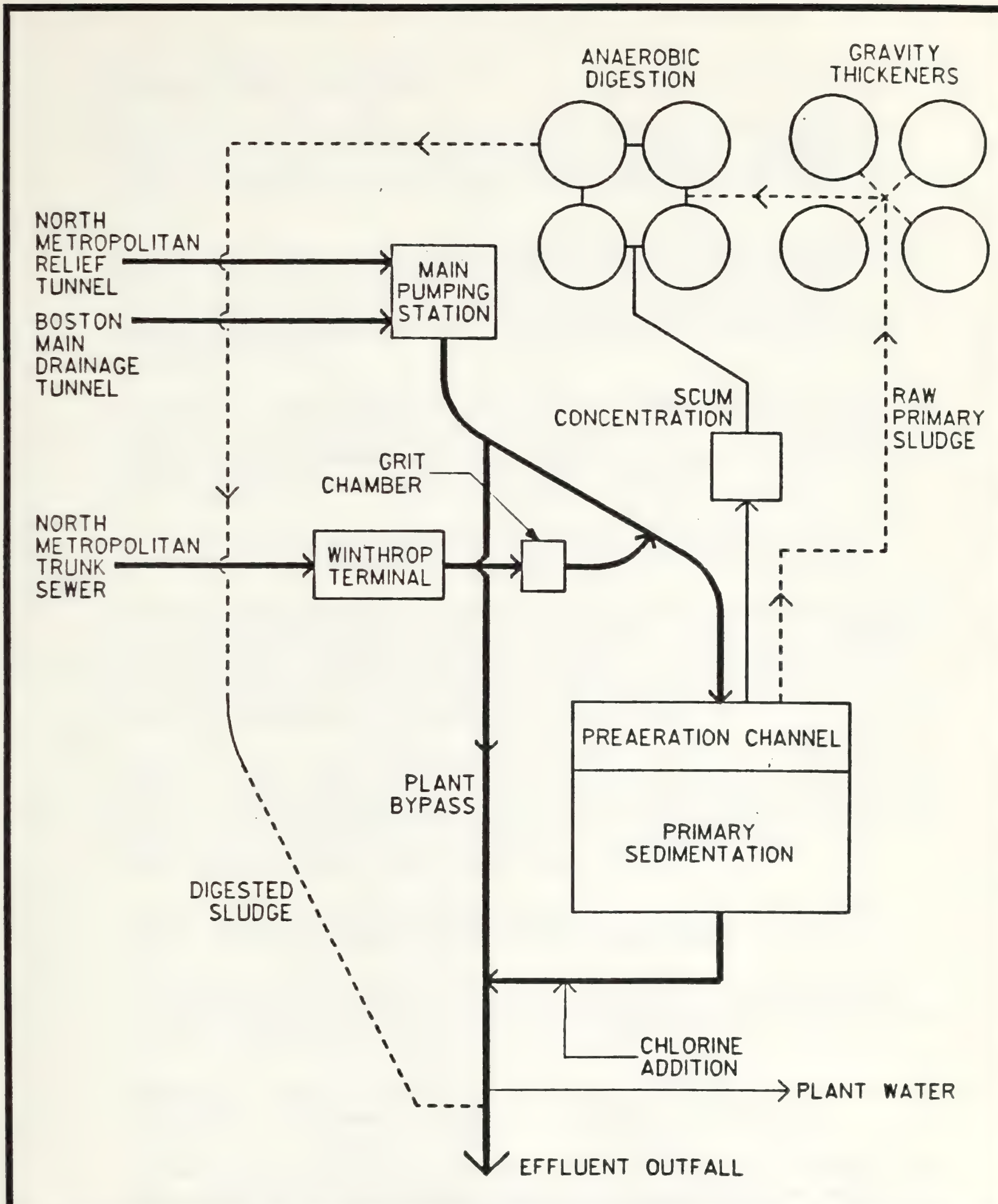

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FIGURE 5.1.1-1
DEER ISLAND
WASTEWATER TREATMENT PLANT
SCHEMATIC

Wastewater Collection - North System

The system of interceptors, pumping stations, and remote headworks that feed the Deer Island treatment plant are referred to as the North Metropolitan Sewerage System. Influent flow enters the Deer Island plant from both the Main Pumping Station and the Winthrop Terminal headworks.

The Main Pumping Station at Deer Island can pump from either of two deep rock tunnels, each constructed 300 ft below sea level. The Main Pumping Station has no wetwell and the two tunnels are not connected. Each pump can draw from either tunnel. Since the hydraulic gradients are different in each tunnel, pump suction connections to each tunnel are controlled by isolating butterfly valves.

The first tunnel, the Boston Main Drainage Tunnel, is approximately 7 miles long. It crosses under Boston Harbor from Deer Island to South Boston, where it connects to the Columbus Park Headworks. The tunnel then continues from Columbus Park to the Ward Street Headworks, located off Huntington Avenue behind the Wentworth Institute of Technology.

The second rock tunnel, the North Metropolitan Relief Tunnel, is approximately 4 miles long. It connects the Chelsea Creek Headworks to the Main Pumping Station at Deer Island.

The Winthrop Terminal Headworks screens and pumps influent flow that arrives at Deer Island via the North Metropolitan Trunk Sewer. This sewer is the original interceptor to Deer Island and is roughly paralleled by the North Metropolitan Relief Tunnel. The North Metropolitan Trunk Sewer receives flows from Winthrop, Orient Heights, and Deer Island and overflows from the Chelsea Creek Headworks by way of the East Boston Pumping Station.

Treatment at the Deer Island plant consists of primary sedimentation, disinfection, and sludge digestion. During peak flows, normally caused by wet-weather flows from the numerous combined sewers of the North Metropolitan System, the Boston Main Drainage and North Metropolitan Relief tunnels are selectively throttled at the three remote headworks, thereby diverting flows in excess of the plant's capacity to handle combined sewer overflows.

When the Ward Street Headworks is throttled, the majority of excess flow is diverted to the Cottage Farm chlorination facility, which discharges to the Charles River.

When the Columbus Park Headworks is throttled, the majority of excess flow is diverted to the Calf Pasture Pumping Station, located in Columbia Point, which pumps the wastewater to the Moon Island outlet, which in turn discharges to Dorchester/Quincy Bay.

At Chelsea Creek, excess flow is diverted via a siphon across the creek to the East Boston Pumping Station and is pumped from there into the North Metropolitan Trunk Sewer.

The North System is operated to maximize the flow from both the Chelsea Creek Headworks and the interconnected Winthrop Terminal Headworks/East Boston Pumping Station system. Because flow

from the Chelsea Creek Headworks is optimized, the system initially throttles flow at either the Columbus Park Headworks or the Ward Street Headworks.

The hydraulic capacities of the existing major conveyance facilities in the North and South Systems are presented below:

North Metropolitan System	Size of line	Peak capacity (mgd)
Boston Main Drainage Tunnel		
(Deer Island to Columbus Park segment)	11'6"	438
(Columbus Park to Ward St. segment)	10'	
North Metropolitan Relief Tunnel	10'	350
North Metropolitan Trunk Sewer	9'	125
Total capacity to Deer Island		913

Main Pumping Station

The Deer Island Treatment Plant Main Pumping Station consists of nine vertical-shaft, mixed-flow, bottom suction sewage pumps. Each pump is rated for 90 mgd at 105 ft total dynamic head (tdh) and 400 rpm. The pumps were designed to be operated over a speed range of 250 to 400 rpm. An empty bay is provided in the pumphouse for a tenth pump.

The pumps are driven by 90-ft-long shafts. Eight pumps are driven by diesel engines, and one pump is driven by a 2,000-hp synchronous electric motor with a variable-speed magnetic (eddy-current) coupling.

The diesels are 12-cylinder, radial-type, vertical-shaft engines furnished by the Nordberg Manufacturing Company of Milwaukee and St. Louis.

Each pump suction piping connects to a bifurcation, which is piped to both the Boston Main Drainage Tunnel and the North Metropolitan Relief Tunnel. Each leg of the bifurcation contains a 60-in-diameter butterfly valve and a 60-in.-diameter rubber expansion joint. The butterfly valves are pneumatically operated with a manual handwheel override. There are no valves on the pump discharge.

The pumps lift the wastewater to the treatment plant by a 60-in-diameter pipe. Each pump discharge has a venturi meter to measure pump flow. Each pump discharge line is arranged as a siphon, and each siphon is equipped with vacuum priming and vacuum-breaking piping and valves. Two vacuum pumps are provided to prime the nine siphons.

The Deer Island Main Pumping Station receives wastewater from the three remote headworks and lifts it to the head end of the treatment plant. The pumping rate is adjusted to maintain a constant water level at the headworks. Pump startup/shutdown and butterfly valve opening/closing are done locally. Adjustment of pump speed is done either manually or automatically in the control room. Pump suction valving is such that any pump can take suction from either tunnel. The original cast iron impellers have been replaced: seven impellers are now stainless steel and two are nickel-iron alloy.

The pump drivers are arranged in two rows (odd numbers to the west, even numbers to the east) at floor elev. 130 ft, the operating floor of the Main Pumping Station. The original plant design includes space allocation for a future pump (no. 10).

Based on discussions with plant operators and a review of the Deer Island Facilities Plan - Volume I Fast-Track Improvement document, the unreliability and high maintenance associated with the Nordberg diesels constitute the most serious problem in the operation of the pump station/powerhouse facilities. These particular engines have been out of production since 1965, and Nordberg Manufacturing Co. is no longer in business. Because of this, replacement parts are extremely expensive and some are virtually unobtainable.

The proposed fast-track improvements to the Deer Island Main Pumping Station, scheduled for completion in 1988, include the following:

- Empty bay (no. 10) and pump bays (nos. 2, 4, 6, and 8) provide:

    - Five new vertical centrifugal pumps, each rated 90 mgd at 105 ft tdh.

    - Four new 2,000 hp synchronous motors, variable-speed eddy-current drives, and reduced voltage starters. One existing 2,000 hp electric motor and variable-speed drive (no. 8) will remain in service.

    - One new 8-in-diameter solid steel shaft, bearings, and couplings (no. 10).

- Four existing shafts (nos. 2, 4, 6, and 8) are proposed to remain in service and be modified to accept new 2,000 hp motors. Condition of existing shafts will be verified by nondestructive testing. Existing bearings will be evaluated and replaced as required. Method of lubricating bearings will be improved. New spacer couplings will be provided to facilitate pump maintenance.

- Existing and new electric-driven pumps will be controlled from a new pump control room to be located on the mezzanine level. New 4,160 V motor starters and variable-speed drive controllers will be installed in a new electrical room also located at the mezzanine level.

- Five existing Nordberg engines, shafts, and pumps (nos. 1, 3, 5, 7, and 9) will remain in service. These pumps will continue to be controlled pneumatically from a local panel at

each engine. Remote auto-manual, speed, status, and alarm conditions will be electronically transmitted to a new pump control room. The existing control room will be abandoned.

- o The existing pneumatic analog pump controller will be replaced with a new electronic analog controller (microprocessor) to accommodate the new electric motor-driven pumps and the new electronic signals from the existing Nordberg engine-driven pumps.

- o The pump suction piping for the five electric motor-driven pumps (nos. 2, 4, 6, 8, and 10) will be revised to include a new 60-in knife gate valve downstream from each butterfly valve (one valve on each leg of the wye). They will be installed without dewatering the tunnel system and will protect the pumping station against butterfly valve failure in the open position.

- o A new 60-in butterfly valve will be installed in the existing discharge piping of pumps no. 2, 4, 6, and 8.

- o New 60-in steel discharge piping, flow meter, and butterfly valve will be installed for the new pump, no. 10 (empty bay).

- o The new discharge valves will allow the pumps to be started against a closed discharge valve instead of a closed suction valve, eliminating the cavitation condition that currently occurs. The new discharge valve will be closed just prior to normal shutdown of the pump.

Power and Utilities

The power station generating capability currently consists of five diesel generator sets provided by the Enterprise Engine & Machinery Company of Oakland, California. The diesels are eight-cylinder, in-line-type engines that can be operated on digester gas or diesel fuel. The generators are rated at 700 kw each and were furnished by Allis Chalmers.

The five diesel generators are arranged side by side and numbered sequentially from north to south, at the operating floor level (elev. 130 ft).

The Enterprise engines are reliable and have good availability.

The following is part of the Fast-Track Improvements Program:

- o The five existing 700-kw diesels will be rehabilitated (under the Power Distribution Rehabilitation Contract) and will remain in service.

- o Two new 6,000-kw dual-fuel diesel engine/generator sets will be installed in a new building addition. New diesel engines will be started/stopped locally at each diesel and controlled from a new control panel in the switchgear room. Alarm and status

indicators will be located at the diesels, in the switch-gear room, and in the new pump control room.

- A new power distribution arrangement will allow the diesels to operate in a parallel configuration or to be separated (five existing diesels on one bus and two new diesels on another bus). In general, the two new diesels will power the electric-driven sewage pumps and the existing diesels will power all plant loads.

- The existing once-through cooling water will be replaced with a closed-loop water system with heat rejection through cooling towers. The new system will recover heat from the jacket water of the Enterprise engines, the new 6,000-kw engines, and the remaining Nordberg engines. The heated closed-loop water will be routed through heat exchangers to provide heat to the sludge-heating water, which in turn will be routed through heat exchangers to heat sludge at the digesters.

Treatment Facilities

Flows from the Main Pumping Station and the Winthrop Terminal are discharged to two preaeration channels, which also serve as distribution channels to the eight primary sedimentation tanks.

Wastewater is conveyed from the Main Pumping Station and Winthrop Terminal to the primaries via a 20-ft-wide by 14-ft-deep concrete channel that flows full. This channel splits into two 10-ft-wide by 14-ft-deep aerated channels, each of which feeds one-half of the primary tanks. Either channel can be isolated from the main influent channel by means of large motor-operated gates.

The two aerated channels are each furnished with one stationary air diffuser and 22 swing-arm diffusers. Positive displacement compressors for these diffusers are located in the Winthrop Terminal Headworks.

From the aerated channels, wastewater is fed into each settling tank through ten manually operated or portable motor-operated 24-in by 42-in sluice gates. There are eight primary settling tanks at Deer Island. Each tank is approximately 100 ft wide by 240 ft long with an average sidewater depth of 11.4 ft. The tanks are equipped with traveling bridge collectors and chain-and-flight cross-collectors. Each tank has approximately 100 ft of straight-edge weir at its effluent end.

Traveling bridge collectors push scum to the effluent end of the tanks, where the bridge pauses for a period of time while a reciprocating scum collector travels back and forth across the width of the tank and pushes scum over a V-notch weir on either side of the tank. Scum from all eight tanks flows to a central sump located between tanks no. 4 and 5, from which point it is pumped to scum thickeners. Sludge is pushed to the influent end of the primary tanks to the cross-collector hopper, where it is moved to one end by a chain-and-flight collector. Sludge is withdrawn from the hopper by 12 sludge pumps, 3 for each pair of primary tanks.

The primary treatment facilities remove settleable and floatable solids within the constraints of their design capacities. Removal depends on the flow rates to the facility and the number of primary tanks available for service.

The westernmost aerated influent channel of the settling tanks has substantial accumulations of grit, nearly reaching the water surface at the downstream end at the time of recent inspection. This may be caused by the poor condition of the swing diffusers, which have never been replaced, higher concentrations of grit to the westernmost channels due to hydraulic anomalies, lack of sufficient mixing air, and/or poor upstream grit removal.

The swing diffusers are in poor condition. Those in the easternmost channel were replaced several years ago and are operable but have serious corrosion problems, with holes completely through the pipe in some places. Those in the westernmost channel are original equipment and are in very poor condition. These diffusers create little visible turbulence and are covered with grit. Plug valves for the diffusers are rusted and some are stuck in the open position.

The inlet sluice gates and inlet baffles to the primary tanks are in poor condition. The sluice gates are opened and closed manually or by portable electric operators. The portable operator sometimes causes the gates to be opened or closed too far, creating high stresses on the gate itself or on the anchoring system. Half of the 80 gates show evidence of these problems. Five gates cannot be fully closed, making dewatering difficult. Maintenance of the sluice gates is hampered by their location on the aeration channel side of the wall (seating head). This means that for adjustments to be made on any one gate, one-half of the plant's primary treatment capacity must be removed from service. Each sluice gate has a steel inlet baffle just downstream of it, inside the tank. These baffles are severely corroded and some are completely missing.

The water level in the effluent channel from the primary tanks was originally maintained by a tainter gate to provide chlorine contact time. A few years after start of operation, this gate became inoperable and was removed. As a result, the water level in the channel is now below the elevation of the scum sump float valve, making it inoperable.

Currently, one scum pump is continuously operating with the scum collection V-notches set to match this flow as closely as possible. However, the pump normally pumps slightly more than this and lowers the water level in the sump until the pump begins taking air.

The scum-collection system has proven to be a problem, particularly in winter months. Scum begins freezing at the V-notch weirs; if it is not broken up and manually pushed over the weir, the buildup begins extending out into the tank. This problem is difficult to overcome, because the scum-collecting mechanism must be started manually; thus, it does not clean the surface every time the traveling bridge delivers a load of scum. Further, the remote and exposed location of the scum collectors does not encourage manual attention, particularly during severe weather, when attention is most required. In the past, this problem has often proved disastrous, bending scum collectors on the traveling bridges and sometimes becoming so severe that tanks have had to be removed from service.

The following problems related to operation of the sludge pumping station have been reported:

1. All of the Homestead crossover valves on the primary sludge pump intakes are frozen in either the open or shut position. Consequently, the middle pump at each station is available as standby for only one of the two tanks.

2. All of the sump pumps at the primary sludge pumping stations either have been removed or are inoperable. None of the pumps has worked for about ten years. As a result, the crossover valves are usually submerged.

3. There are no check valves on the primary sludge pump discharge pipe.

4. The water seal glands and piping are corroded and in poor condition for all 12 primary sludge pumps.

5. For most of the primary sludge pumps, the coupling guard protection is gone.

6. Most of the primary sludge pump pressure gauges are rusted out, and none works.

The electrical power system and controls for many of the traveling bridge collectors are in poor condition. Much of the electrical conduit is badly rusted and most of the timers for short- and medium-pass bridge travel modes are inoperable or removed. Some chain and sprocket guards for the traveling bridges are badly rusted.

Turnbuckles and cables used for raising and lowering the sludge and scum collector blades are a constant problem because of corrosion and breaking. Cable and turnbuckles often break. When this occurs, the sludge scraper falls to the bottom of the tank and often becomes bent.

Originally, a bus bar supplied power to the traveling bridges. This caused severe problems during cold or wet weather, and the system was replaced with festooned cable. The cable has proven fairly reliable, except that occasionally a cable ring breaks and drops the cable to the rail, where it is cut by the bridge wheel, putting the unit out of service.

The proposed Fast-Track Improvements Program at the Deer Island primary treatment facilities includes the following components:

- Replacement of all 80 influent sluice gates and baffles to the primary tanks
- Replacement of the sludge collectors and traveling bridge drives and hoists
- Rehabilitation of the traveling bridges
- Installation of new scum-collection and pumping systems

Plant effluent is disinfected with gaseous chlorine. Chlorine can be used to disinfect plant effluent, for prechlorination just prior to the primary tank preaeration channels, for prechlorination of influent flows to the Winthrop Terminal Headworks, and for disinfection of nonpotable plant water.

Chlorine is delivered to the Deer Island plant in two 16-ton tanker trucks, which are stored in the chlorine storage room. Each chlorine tanker truck is located on a separate weigh scale. Chlorine is withdrawn from the tankers and piped to a separate chlorine feed room that houses seven evaporators and seven chlorinators. Injectors are operated by nonpotable plant process water and booster pumps. The injectors pull chlorine from the chlorinators under vacuum and inject it at the various application points.

The existing chlorination system is at the end of its useful life. The following problems were observed:

1. The liquid chlorine supply lines are severely corroded. Availability of wrenches and safety equipment to make the supply line connection with the tanker truck dome valving should be improved.

2. Some of the overhead doors to the garage have deteriorated to the point where they either do not open or do not close. Some windows are inoperable.

3. The chlorine-supply island should have an additional escape route to be used in the event of a chlorine leak.

4. The HVAC for the garage does not work.

5. Parts for original chlorinators are difficult or impossible to obtain.

6. The automatic controls for the chlorination equipment do not always function properly.

7. The chlorine gas detection system is antiquated and does not tell the operator where a leak has occurred. This detection system does not detect leaks in every room in which chlorine is handled.

8. Piping and valving for the chlorine solution is in extremely poor condition. Some injectors have developed leaks.

9. The solution piping to prechlorination is currently disconnected, reportedly because it developed a leak in a buried section.

10. There is sometimes inadequate vacuum produced by the injectors to operate the chlorinators.

11. There was a major leak in the chlorine-solution feed piping during the last few years. The chlorine solution backfed into the Winthrop gravity sewers and caused the residents of the community major concern. The chlorine-diffusion system in the primary sedimentation effluent channels was recently replaced and is in good condition.

The Deer Island Fast-Track Improvements Program includes replacements and upgrading of the chlorination system. New process equipment, scales, chlorinators, evaporators, piping, instrumentation, electrical, HVAC, and safety systems will be provided. A building addition will also be provided to house a scrubber system, which will contain any chlorine leaks.

Outfall

There are five outfalls from Deer Island, designated by the EPA as 001, 002, 003, 004, and 005. Construction dates back to the 1890s. The newest outfall was constructed in 1964.

Outfall 002 is the oldest. It was constructed in three phases. The first phase was built in 1891, which consisted of the portion on Deer Island, a 63-1/2 in by 60 in-wide, egg-shaped, brick-lined concrete tunnel leading to a shoreline outlet. The second phase was built in 1895. This extended the outfall to about one quarter of a mile offshore in a southerly direction into President Roads channel. Approximately one-third of the length of conduit installed in this phase consists of a 63-1/2-in diameter brick-lined tunnel. The remainder is a 63-1/2-in diameter pipe built up from wood stave, with a brick lining set in Portland cement. The pipe is anchored to pile bents, buried, and protected with riprap. The outlet was an upturn flush with the harbor bottom.

The third and final phase of Outfall 002 was installed in 1917. It consists of an approximately 300-ft extension of 60-in-diameter cast iron pipe. The first 200 ft is buried and protected with riprap. A partially buried diffuser makes up the last 100 ft. Thirteen elliptically-shaped ports were cast into the top of the iron pipe, and the end has a 48-in-diameter opening. When this extension was installed, the vertical outlet of the previous 1895 phase was capped off.

Outfall 003 was originally constructed as a bypass to be used during the installation of the diffuser or third-phase extension of Outfall 002. It is approximately 800 ft long. About half of this outfall is on the island and consists of 78-in-diameter formed-in-place concrete pipe. The offshore portion extends to the southeast to a vertical outlet about one-tenth of a mile from the island. It is constructed of 60-in-diameter cast iron pipe buried and protected with riprap. The outlet is flush with the harbor bottom.

Outfall 001 was installed in 1964 as a part of the primary treatment plant project constructed on the island for the North Metropolitan Sewerage System. It consists of a buried 120-in-diameter, reinforced-concrete pipe protected with riprap. The outfall extends about one-half mile offshore to the south-southeast into President Roads channel. It terminates in a diffuser approximately 250 ft long.

The diffuser nozzles are 20 in in diameter and are arranged in pairs angled at 45 degrees to the vertical. The pairs are spaced on 8-ft centers over the length of the diffuser, which steps down in size from 120-in diameter to 108-in diameter to 60-in diameter. A short end piece consists of three staggered nozzles with a 30-in-diameter upturned opening in the end. There are a total of 58 nozzle ports. The diffuser section is buried up to the nozzles and protected with riprap.

Outfalls 004 and 005 are relief bypasses installed for use during the construction of Outfall 001. They consist of buried, 108-in-diameter reinforced-concrete pipe. Outfall 004 extends offshore in a southerly direction a few hundred feet from its connection to the pipe leading to Outfall 001. The outlet is simply the open end of the pipe. The area over the pipe and around the outlet is protected with riprap. Outfall 005 has a shoreline outlet connecting to the pipe leading to Outfall 001 upstream of Outfall 004. It discharges on the west shore of the island a few hundred feet north of Outfall 004. The outlet is similar to that of 004. Outfalls 003 and 004 are currently used when the capacity of Outfalls 001 and 002 is exceeded. Outfalls 005 is not used for excess flow, but only if repair work is being done on the other outfalls.

Section 5.1.1 Reference

Metcalf and Eddy. 1982. Nut Island Wastewater Treatment Plant Facilities Planning Project, Phase I, Site Options Study, Commonwealth of Massachusetts Metropolitan District Commission.

5.1.2 NUT ISLAND TREATMENT PLANT

Wastewater Collection - South System

The South Metropolitan Sewerage System's High-Level Sewer (HLS) conveys wastewater to the Nut Island Treatment Plant in Quincy. There are no remote headworks on the South Metropolitan Sewerage System. The HLS sewer is fed by various upstream interceptors and force mains. It has a maximum capacity of 360 mgd.

The South Metropolitan Sewerage System consists of a network of approximately 78 miles of MWRA interceptor sewers, five pumping stations owned and maintained by the MWRA, and the existing Nut Island Treatment Plant.

The HLS begins in the Parker Hill section of Roxbury, just south of the North Metropolitan System's Ward Street Headworks. The length of the HLS is about 15 miles and extends through Hyde Park, Milton, and Quincy to the Nut Island plant. Along the sewer route, major flows are received from MWRA extension sewers, including the Brighton branch, Neponset Valley sewer, Upper Neponset Valley sewer, New Neponset Valley sewer, Wellesley extension sewer, and Wellesley extension relief sewer.

Influent flows are also received from the Merrymount, Squantum, Braintree-Weymouth, and Hough's Neck pumping stations. The cross-sectional size of the sewer ranges from 8 ft-3 in by 9 ft-6 in in the upstream reaches to 11 ft-3 in by 12 ft-6 in at the entrance to the treatment plant. The average slope of the HLS is approximately 1 ft per 3,370 ft (0.0003), with the invert of the sewer dropping a total of 24 ft from Parker Hill to the plant. The HLS was generally constructed of either brick or concrete in the excavated sections and was tunneled in some sections, depending on the depth and soil conditions.

Treatment Plant

The Nut Island treatment facility was completed in 1952. It provides preliminary and primary treatment for the South Metropolitan Sewerage System. The facility was designed to treat an average day flow of 112 mgd and a peak day flow of 300 mgd. Collection of wastewater from communities served by the system is routed through the HLS to the treatment facility.

Flow enters the treatment facility at the headworks, where it is channeled to two catenary-type bar screens. From the screening area, wastewater is diverted to six grit chambers. The screened, degritted wastewater flows to the main sewerage pumps' wetwell for pumping to the preaeration and primary sedimentation basins. Preaeration is provided by five preaeration basins, each 21 ft by 167 ft. Primary sedimentation is provided by six basins 64 ft by 185 ft with a 13-ft sidewater depth. Treated wastewater is disinfected and discharged to the harbor through the outfalls. Sludge and grease from the sedimentation basins are anaerobically digested in four complete mix digesters, each with a capacity of 2.3 million gallons. Three digesters are operated under normal conditions, with one digester set aside for maintenance. Sludge is pumped to all three digesters; however, the digested sludge from two of the digesters is pumped to the third before discharge. Digested sludge is disinfected and discharged to the harbor off Long Island through the sludge outfall.

Since 1984, the following improvements have been implemented:

1. Power

   - Rebuilding of one engine generator

   - Installation of a 2000-kva transformer for purchased off-site power to the site

2. Preliminary Treatment

   - Addition of an influent flow meter (sonic type) on the HLS

   - Installation of a new ventilation system, odor control equipment, and explosion-proof electrical components to the grit facilities

   - Removal of comminutors downstream from the grit chambers

- Rebuilding of the effluent channels from the grit tanks
- Replacement of the air header to the preaeration basins
- Rebuilding of one preaeration blower motor

3. Primary Sedimentation

   - Structural rebuilding of tanks and repairing of leaks
   - Leveling of tank floors
   - Replacement of all weirs
   - Replacement of sludge collection equipment

4. Digesters

   - Replacement of outside sludge piping from the primary sludge pumps to the anaerobic digesters

5. Outfalls

   - Installation of an automated sluice gate at the outfall
   - Cleaning of the two main outfalls

Outfall

There are five outfalls from Nut Island designated by the EPA as 101, 102, 103, 104, and 105. Construction dates back to the turn of the century.

Outfalls 101 and 102 were built in 1904 as part of the screening and sandcatcher facility. They each extend in a northerly direction approximately one mile offshore into the Nantasket Roads channel area of the harbor. They are constructed of 60-in-diameter cast iron pipe. The pipe is buried and protected with riprap. The outlets were originally simple, single upturns, flush with the harbor bottom.

Outfall 103 was built in 1914 to add capacity to the 1904 sandcatcher facility. It extends approximately one-quarter of a mile offshore into Quincy Bay, paralleling the original outfalls. It consists of a buried 60-in-diameter cast iron pipe protected with riprap. The

outlet, like those of 101 and 102, is a simple upturn, flush with the harbor bottom.

In the period between 1946 and 1952, a primary treatment facility was added to Nut Island. Along with it came the construction of two new outfalls, 104 and 105, and modification of two of the existing outfalls.

The outlets to Outfalls 101 and 102 were capped to form hexagonal side discharges. It is presumed that this was done to improve mixing of the effluent with the ambient harbor water.

Outfall 104 extends east of Nut Island, about one-tenth of a mile into Hingham Bay, and has a single horizontal outlet. It is a buried 60-in-diameter reinforced concrete pipe intended to be an emergency bypass to carry the overflow when the capacity of the original three outfalls is exceeded.

Outfall 105 is a 12-in-diameter cast iron sludge line. It extends about 4 miles in a northerly direction to a point near the north end of Long Island in the President Roads channel area of the harbor. It has a specially-shaped, slotted outlet designed to promote mixing.

Outfalls 101 and 102 underwent a major cleaning operation in 1985-86 to increase their capacity. Prior to this, the short outfalls, 103 and 104, were in use for longer periods than originally intended because of the deteriorated capacity of Outfalls 101 and 102. The increased use of 103 and 104 was a concern because of their closer proximity to Nut Island and the beaches in the City of Quincy.

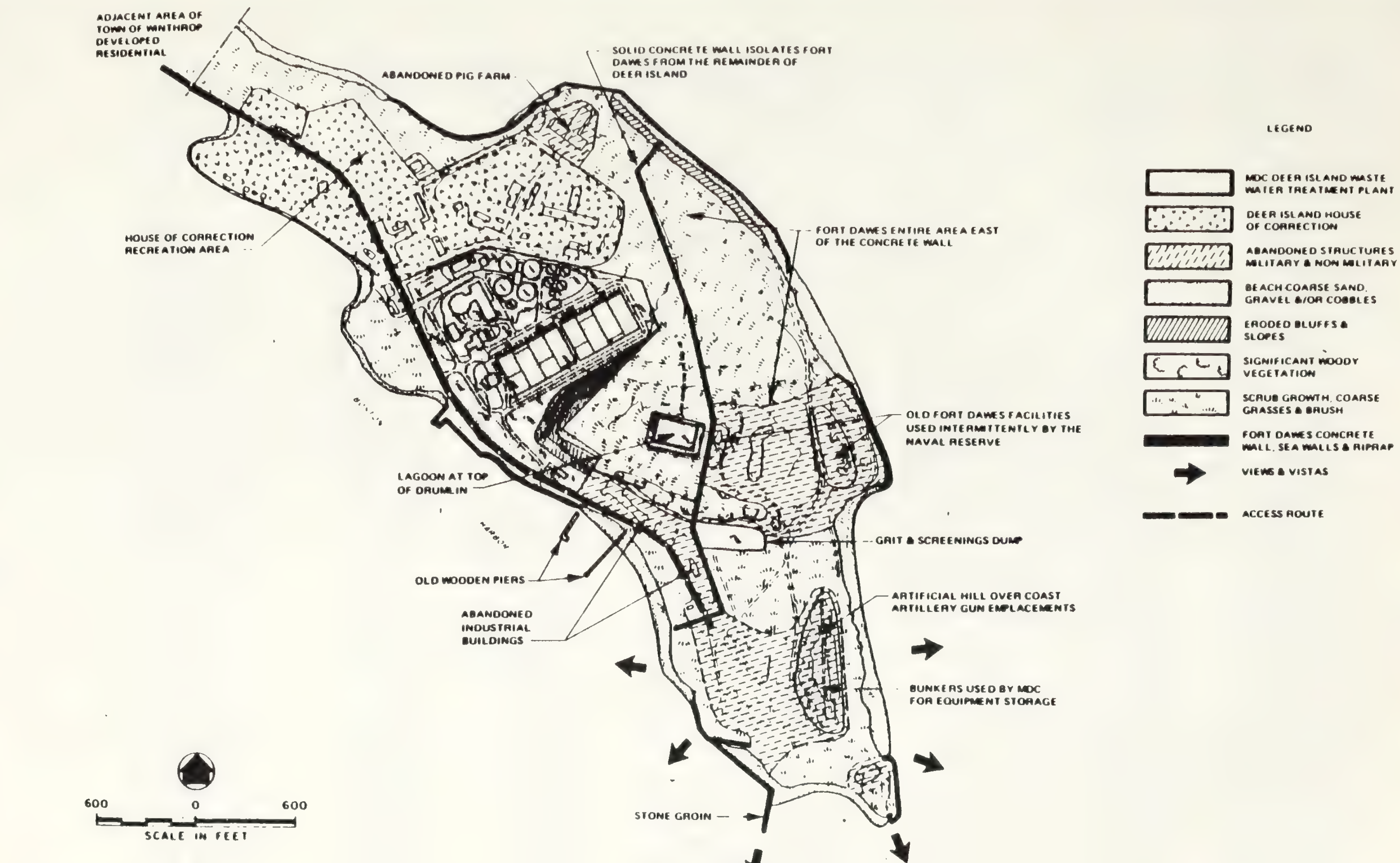
5.2 EXISTING ENVIRONMENT

5.2.1 LAND USE

Deer Island

Deer Island, connected to the southern tip of Winthrop, is 203 acres in size (refer to Figure 5.2.1-1). The two active land uses are the Deer Island House of Correction, owned and operated by the City of Boston, and the MWRA's existing 343-mgd primary treatment facility for the North service area. Combined, these facilities occupy a total of approximately 60 acres toward the landward side of the island. Except for the treatment plant and prison structures, almost all of Deer Island is open space with recreational use limited to prison recreation areas and passive recreational areas used by prison and treatment plant employees. Occasional visitors use the south end of the island for passive recreation.

Deer Island is zoned "B-1, General Business" by the City of Boston. This classification allows all commercial and residential uses, but excludes industrial or other nonconforming uses without a variance. The existing nonconforming uses of the prison and the treatment plant predate the zoning classification.



SOURCE: Metcalf & Eddy, June 1982

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 5.2.1-1
DEER ISLAND EXISTING CONDITIONS

The Deer Island House of Correction has over 450 inmates with more than 4,000 visitors annually. House-to-house searches undertaken in the neighborhood and the use of sirens following prison escapes (20 during 1983) have irritated neighborhood residents. Past concerns for the prison's problems and proximity to residential areas have led to local, state, and federal efforts to relocate this facility. Relocation is currently scheduled for 1989 or 1992.

Although a prison and a wastewater pumping station have been located on Deer Island for nearly 100 years, it was after the hurricane in 1936 that these metropolitan uses on Deer Island began to be more closely associated with the Point Shirley neighborhood. Prior to this time, Shirley Gut and its swiftly moving currents physically separated Deer Island from Winthrop.

In earlier years, access was by ferry. However, in 1936, hurricane winds and tides deposited sand and silt that connected the Island to Winthrop. This was consolidated and made into a causeway permanently linking the two areas. Loss of the gut reduced the flushing action around Deer Island and brought the island into closer association with the Town of Winthrop (even though Deer Island remained a part of the City of Boston).

The Point Shirley and Cottage Hill neighborhoods are the communities closest to Deer Island. They are situated on a narrow peninsula, with Point Shirley connected to Deer Island and separated from Winthrop by a causeway. The neighborhoods are predominantly residential, with approximately 450 residences and a population of about 1,000 people in Point Shirley and about 1,400 residences and approximately 3,400 people in Cottage Hill. A majority of the homes, originally built as summer cottages, have been winterized and are used on a year-round basis. Most major commercial activity in Winthrop is located along the main truck route to Deer Island. Zoning in Point Shirley, Cottage Hill, and throughout much of Winthrop is "Residence A, Single Family Use."

The construction of a wastewater treatment plant by the MDC in the 1960s was initially perceived as a positive development in the neighborhoods. Over time, the increasing lack of funds for maintenance has resulted in a gradual deterioration of this facility, which has become a nuisance and an irritant to the local community.

Areas surrounding Deer Island can be characterized as residential in Winthrop to the northwest, transportation-oriented at Logan International Airport to the west, open/institutional on Long Island and the President Roads shipping channel to the south, and open water (Broad Sound and the Atlantic Ocean) to the north and east.

Nut Island

Nut Island in Quincy was once a 4-acre island located just north of Quincy Great Hill on Hough's Neck. In 1893, the MDC built a road to the island and enlarged it to accommodate a pumping and screening station and outfall. In 1949, the island was again enlarged. The present primary treatment plant and associated facilities occupy the entire 17-acre area of the

island; no land use other than for wastewater treatment and disposal exists on Nut Island. Figure 5.2.1-2 shows the existing Nut Island conditions.

Nut Island has recently been rezoned by the City of Quincy to "Open Space" classification. This classification would not allow for building structures on Nut Island. Refer to Section 8.6, which discusses institutional considerations associated with zoning classification.

Currently, Nut Island offers limited recreational potential. Except for the buildings at the north end, Nut Island is entirely open; however, most of this space is covered with asphalt and concrete. The only observed recreation on the island has been children occasionally playing during the summer and adults parked at the north end apparently taking advantage of the harbor view. Recreational fishing is also popular in the waters around the island.

Long Island

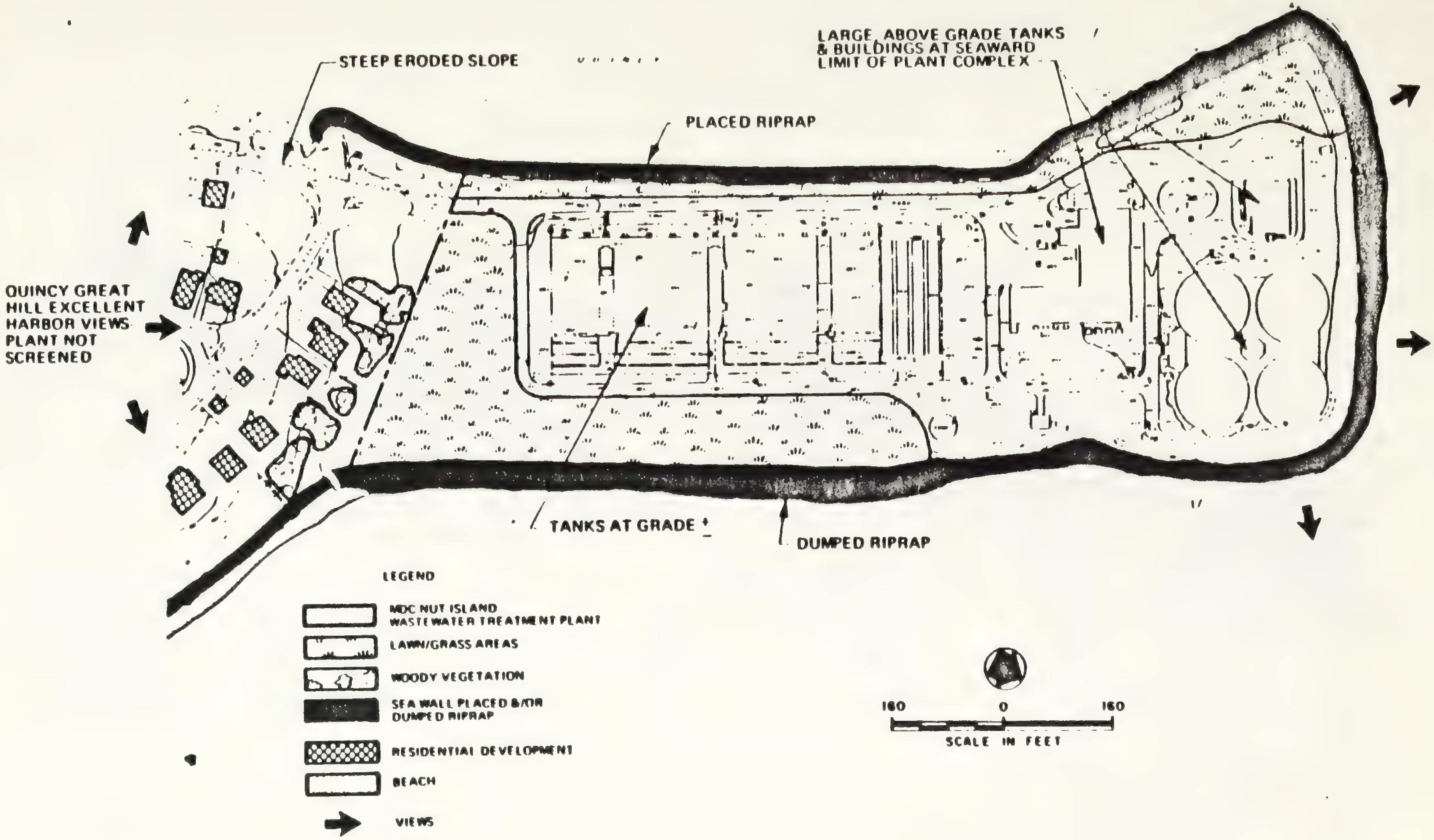
Long Island, with a land area of 213 acres, is the largest of the harbor islands and is situated near the exact geographic center of Boston Harbor. It is connected to the mainland by a two-lane bridge that is nearly 35 years old. Figure 5.2.1-3 shows the existing conditions on Long Island.

The island currently supports only one active land use, the Boston Chronic Disease Hospital, which consists of approximately 20 buildings and occupies about 60 acres of the north-central portion of the island. In 1972, the hospital contained a population of about 450 patients and a staff of approximately 400 (M&E, 1982).

The remainder of the island, not occupied by the hospital, is a mixture of vacant, open land and abandoned military installations. The 100-ft-high drumlin at Long Island Head is the site of Fort Strong, which, until 1956, hosted a series of coastal defense batteries that were initially established prior to the Civil War. While all of the fort's barracks and most of its support structures have been razed, the casemates, magazines, gun positions, and heavy concrete and stone fortifications remain. Also on the island, in the southwesterly quadrant, is an obsolete site used for a defensive Nike missile installation, a cemetery with unmarked graves, and a cemetery and monument to 79 Civil War Dead.

Vacant, open land on the island is of several distinct types. The low-lying open area that was the parade ground at Fort Strong contrasts sharply with pine woods and marsh areas of West Head, located at the southern tip of the island. Long Island is located within a B-1 (General Business) land-use zone. (M&E, 1982).

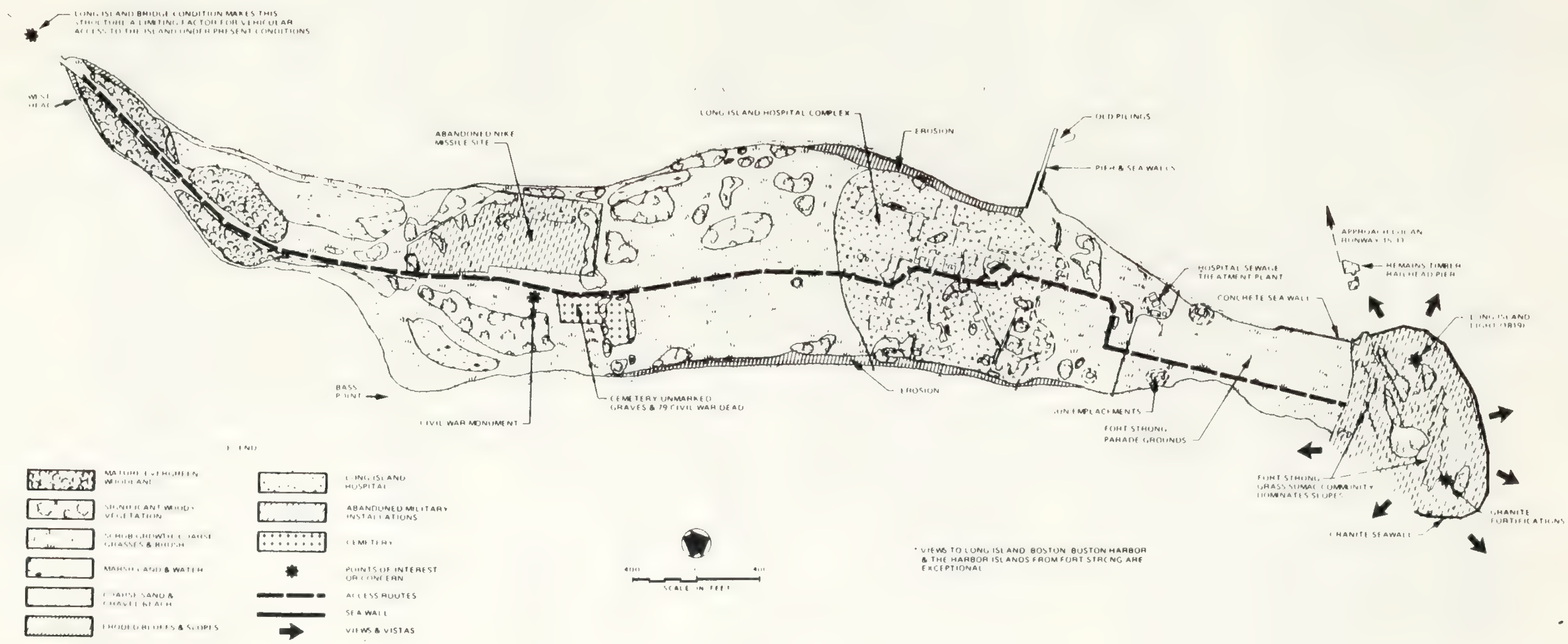
Long Island has significant open space, a variety of shoreline characteristics, historic structures, interesting topography, and one institution, the above-mentioned Boston Chronic Disease Hospital, which has dwindled in population over the past ten years. Considering all of these factors, Long Island has considerable potential for development as a significant outdoor recreation facility (M&E, 1982).



SOURCE: Metcalf & Eddy, June 1982

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 5.2.1-2
NUT ISLAND EXISTING CONDITIONS



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 5.2.1-3
LONG ISLAND EXISTING CONDITIONS

All of Long Island is proposed to be developed for recreation purposes, with high-intensity uses at the head and moderate uses in the southern half of the island (C.E. Maguire, 1984). It is assumed, however, that the Long Island Hospital compound will remain.

The primary access to and from the island during the summer months would be via scheduled ferries. Internal access between the Head and the southern portion would be by shuttle van. Some controlled access through the Squantum community for bicycles would be permitted. Extended-season access for spring and fall could be provided by shuttle bus from the mainland.

Major new elements to be developed as part of the plan will include a pier and visitors' center, a transportation exhibit in the historic lighthouse, the major gun emplacements from Fort Strong, a cultural museum (proposed by the City), major picnic and sitting areas, playing fields, and interpretive trails with viewing points. Development costs are estimated at $5.5 million for the Head (C.E. Maguire, 1984).

For the southern portion of the island, the new major elements include an environmental study complex, a swimming beach, and an extensive system of hiking and bicycling trails with numerous overlooks. The development generally focuses on sensitively exploiting the island's natural features, including a large wet meadow, a dune environment, a large succession meadow, and a large grove of mature pines. Should use levels indicate a need, the beach area could be expanded and a day camp established at the former Nike site. Development costs for the southern portion of the island is estimated at $2.1 million (C.E. Maguire, 1984).

Future use is projected at 2,500 visits per average weekend day for the Head area, and 1,500 at the southern end with most of the latter occurring on the beach (C.E. Maguire, 1984).

Section 5.2.1 References

C.E. Maguire. 1984. Supplemental Draft Environmental Impact Statement/ Report on Siting of Wastewater Treatment Facilities for Boston Harbor Vol. 1. U.S. Environmental Protection Agency/The Commonwealth of Massachusetts, 242 p.

Metcalf & Eddy. 1982. Nut Island Wastewater Treatment Plant Facilities Planning Project - Phase I - Site Options Study, Vol. II. Commonwealth of Massachusetts, Metropolitan District Commission, 321 p.

5.2.2 TERRESTRIAL ECOLOGY

Deer Island

Descriptive information for Deer Island was derived from a review of literature pertaining to the island and from site visits. Literature reviewed is listed in the references and as specific credits given in the text. Site visits were made by Stone & Webster ecologists in

1976 and again in 1986.

Site Conditions. Deer Island is a large island of about 210 acres, dominated by a large grass-covered drumlin over 100 ft high (Figure 5.2.1-1). This drumlin, like many of the features of the harbor islands, is a geological formation resulting from the accumulation of till, clay, and other materials flushed from beneath the ice sheets of 10,000 years ago. Prior to European settlement, the island probably had a community of deciduous forest, with stands of pines also common (Metcalf & Eddy 1982). Because of the relatively isolated nature of the island site and its exposure to wind and sea salt, any change in the nature of the ecosystem takes a long time to repair itself. Thus, the historical land uses of the site have drastically altered the native vegetation. The present conditions tend to favor communities that form as a fire subclimax (Metcalf & Eddy 1982). These conditions include:

- Topography that favors rapid drying
- Regeneration from undamaged underground plant parts
- Porous soil
- Seeds enclosed in fire-resistant woody fruits

Flora. A majority of the present-day site is either used for urban (commercial/institutional) activities or covered with a scrub growth of coarse grasses and brush (Figure 5.2.1-1). The northwest portions of the island are primarily occupied by the existing wastewater treatment plant and are vegetated, if at all, by scattered grasses and forbs.

Scrub areas along the western side of the island to the south of the wastewater treatment plant are primarily old fields dominated by ragweed (Ambrosia artemisifolia). In the low, damp areas, ragweed exceeds 1.5 meters in height. Wild carrot (Daucus carota), chicory (Cichorium intybus), and goldenrod (Solidago spp.) are also abundant. Along the concrete wall, field bindweed (Convolvulus arvensis), common tansy (Tanacetum vulgare), dwarf cinquefoil (Potentilla canadensis), snowy campion (Silene nivea) and bittersweet (Solanum dulcamara) are common.

North-northwest of the old pumping station, the slope rises steeply. This area is approximately one meter high and is dominated by grasses. Ragweed, wild carrot, and milkweed are at the base of the slope. The walkways around the buildings of the pump station are overgrown with numerous other forbs.

The slope above the pumping station is an abandoned orchard, dominated by apple (Pyrus sp.), black cherry (Prunus serotina), and staghorn sumac (Rhus typhina). On the central and southern sections of the island is an old field dominated by unidentified grass species (Gramineae). Rabbit's-foot clover (Trifolium arvense), daisy fleabane (Erigeron sp.), common burdock (Arctium minus), milkweed (Asclepias sp.), and bouncing bet (Saponaria officinalis) were also present. This area also contains scattered clumps of trees of diverse mixtures, including black cherry, Indian bean (Catulpa sp.), quaking aspen (Populus tremuloides), cottonwood (Populus deltoides), sugar maple (Acer sacchrum), and others.

To the east of the Fort Dawes concrete wall, the island is primarily grassland. The area contains scattered shrubs such as bayberry (Myrica pensylvanica), in occasional clumps with giant reed (Phragmites sp.) in the low areas.

Fauna. The varied nature of the site presents an equally varied habitat for wildlife species. On the west slope of the drumlin, the old field vegetation and the clumps of pioneer tree species all present sufficient cover and forage for numerous bird and mammal species.

Mammals - Reconnaissance of the island revealed that a number of mammals frequent the area. Cottontail rabbits (Sylvilagus sp.) and striped skunk (Mephitis mephitis) have been observed on the island (Table 5.2.2-1). Raccoons (Procyon lotor) and numerous rodents have been found on the island (Boston Harbor Comprehensive Plan 1972).

Birds - A number of bird species have been observed on the island (Table 5.2.2-1). Pheasant (Pasianus colchicus), red-winged black bird (Agelaius phoeniceus), bluejay (Cyanocitta cristata), plovers (Charadriidae), herring gulls (Larus argentatus), great black-backed gulls (L. marinus), swallows (Hirundinidae), and crows (Corvus brachyrhynchos) were observed on the island. Of particular note was the sighting of three sparrow hawks (Falco sparverius) hunting over the island. The presence of three raptors in the area suggest the presence of ample game in the form of insects and rodents (S&W Mgt. Cons. 1976).

Reptiles and amphibians - Few or no amphibian or reptile species are expected to inhabit the island because of lack of suitable habitat.

Endangered and Threatened Species. No endangered or threatened species are known to inhabit Deer Island. The U.S. Department of Interior (USDI) list of species protected under the Endangered Species Act of 1973, as amended, contains only four species of terrestrial vertebrates whose geographic range includes Massachusetts (USDI 1986).

Mammals - The Indiana bat (Myotis sodalis) has been recorded in a single locality in Massachusetts (Chancy 1976). Although no individuals have been found in many years, the bat may still occur in the emery mines in Hampden County, Massachusetts. The mines have been given to the Massachusetts Division of Fisheries and Wildlife in an effort to protect remnants of the bat's population. It is unlikely that this species would be found on Deer Island.

Birds - The bald eagle (Haliaeetus leucocephalus) and peregrine falcon (Falco peregrins tundris and F. p. anatum) are listed as endangered. The bald eagle is characteristically a bird of seacoasts, large remote lakes, and river shores. Today no known breeding populations are found in the state. However, a hacking program by state and federal wildlife agencies (28 eaglets in five years at the Quabbin Reservoir) has reintroduced the bird to Massachusetts (Dyer 1987). The program is scheduled to continue for another three years.

The 1987 winter bird survey found 42 eagles (possibly including a few golden eagles) in the

TABLE 5.2.2-1

FLORA AND FAUNA
OBSERVED AT DEER ISLAND

WOOD SCRUB

Type	Scientific name	Common name	Occurrence
Trees	Pyrus sp.	Apple	Abundant (a)
	Prunus serotina	Black cherry	Abundant
	Prunus sp.	Cherry	Common (b)
	Catalpa sp.	Indian bean	Infrequent (c)
	Rhus typhina	Staghorn sumac	Common
	Rhus glabra	Smooth sumac	Common
	Populus tremuloides	Quaking aspen	Infrequent
	Populus grandidentata	Bigtoothed aspen	Infrequent
	Populus deltoides	Cottonwood	Infrequent
	Acer sacchrum	Sugar maple	Infrequent
	Acer rubrum	Red maple	Infrequent
	Crataegus sp.	Hawthorn (d)	Infrequent
Shrubs and vines	Rubus canadenisi	Blackberry	Common
	Vitis sp.	Grape	Infrequent
	Asparagus sp.	Asparagus	Infrequent
	Rose sp.	Rose	Infrequent
	Myrica pensylvanica	Bayberry (d)	Infrequent
	Spiraea sp.	Spirea	Common

OPEN FIELD

Type	Scientific name	Common name	Occurrence
Forbs	Daucus carota	Wild carrot	Abundant
	Ambrosia artemisiifolia	Common ragweed	Abundant
	Solanum dulcamar	Deadly nightshade	Common
	Datuar strumonium	Jimson weed	Infrequent
	Solidago spp.	Goldenrod	Common
	Cichorium intybus	Chicory	Common
	Tanacetum vulgare	Common tansy	Common
	Trifolium arvense	Rabbit's foot clover	Infrequent
	Potentilla canadensis	Dwarf cinquefoil	Infrequent
	Asclepias sp.	Common milkweed	Common
	Gramineae	Grasses	Common, abundant
	Convolvulus arvensis	Field bindweed	Common

TABLE 5.2.2-1 (Continued)

Type	Scientific name	Common name	Occurrence
	Saponaria officinalis	Bouncing bet	Common
	Silene nivea	Snowy campion	Common
	Arctium minus	Common burdock	Infrequent
	Erigeron sp.	Daisy fleabane	Infrequent
	Petunia sp.	Petunia	Infrequent
	Solanum sp.	Tomato	Infrequent
	Linaria vulgaris	Butter and eggs	Common
	Phragmites sp.	Giant reed	Common
		FAUNA	
Mammals	Sylvilagus spp.	Cottontail rabbit	Common
	Mephitis mephitis	Striped skunk	Common
	Procyon lotor	Raccoon	Infrequent
	Rodentia	Mice and moles	Common, abundant
Birds	Agelaius phoeniceus	Redwinged black bird	Abundant
	Cynocitta cristata	Bluejay	Common
	Corvus brachyrhynchos	Crow	Common
	Larus argentatus	Herring gull	Abundant
	Larus marinus	Great blackbacked gull	Common
	Hirundinidae	Swallow	Abundant
	Charadrius sp.	·Plover	Common
	Pasianus colchicius	Ringnecked pheasant	Common
	Falco sparverius	Sparrow hawk	Common

(a) Frequently found, wide distribution.
(b) Often found, scattered distribution.
(c) Seldom found, scattered distribution.
(d) Old field vegetation.

Quabbin Reservoir area and 54 eagles statewide (Dyer 1987). So far, none has nested in the area, but sexual maturation takes five years and nesting may occur in the next few years. Although it is highly unlikely that bald eagles, even with an increase in their numbers, will ever nest in the harbor islands because of the levels of human activity (Dyer 1987), there is now the possibility of eagles visiting the area while migrating to other parts of New England.

Native breeding populations of the peregrine falcon have been completely extirpated throughout the eastern US, and the arctic peregrine now occurs in the region as a spring and fall migrant. The American peregrine falcon has been successfully reintroduced along the east coast, particularly in Boston (Horwitz 1986). It is the only species listed by the Federal government as endangered that is likely to be found near Deer Island. A pair of peregrines, a three-year-old Boston male and a three-year-old Canadian female, have taken up residence on the McCormick Courthouse Building in Post Office Square and have successfully nested (French 1987a). This is the first successful nest in Massachusetts in 36 years (French 1987b). These birds hunt primarily in the Boston Harbor islands and thus have a high likelihood of visiting Deer Island.

Of the vertebrates listed in Massachusetts as "threatened" (Ritzer and Franzen 1975), only one species, the Ipswich sparrow (Passercules princeps), could occur in the area of the harbor islands. The sparrow, classified as a subspecies of the Savannah sparrow, breeds only on Sable Island, off the southern coast of Nova Scotia. It winters along beaches, sand dunes, and coastal marshes from Massachusetts to Georgia.

Sensitive Communities. The Massachusetts Natural Heritage Program (Michaud 1987) has no record of any rare plant or animal species or unusual plant communities on Deer Island. National Wetlands Inventory maps show no freshwater wetlands on Deer Island, other than the wastewater treatment plant reservoir at the top of the drumlin (USDI, 1987). No wetlands qualifying under M.G.L. Chapter 131, S40 were found during the site visits.

Environmental Stress. Major environmental stress that can alter growth and development of biota includes plant diseases, insect pests, pesticides, fire, drought, winds, ice and snow, agriculture activities, air pollution, recreational activities, and, occasionally, vandalism. Deer Island has served as a site for a variety of municipal facilities dating back to colonial times. It has been the site of an internment camp for hostile Indians, a reformatory, and a quarantine hospital, and has served as the outlet for the metropolitan area's wastewater since the late 1860s. It also was the site of a cemetery and burial areas.

A majority of Deer Island has been subjected to extensive modifications and disturbance, particularly within the last 100 years. The most extensive have included the construction of concrete bunkers, radar and radio facilities, and access roads. Related grading of slopes associated with Fort Dawes (1941) disturbed a substantial amount of the drumlin and land areas to the south. The subsequent construction and modifications of the Deer Island treatment plant (1968) added to this disturbance over the central part of the island. The prison and prior uses in the northern part of the site had previously disturbed the area to the north and northwest of the drumlin. The treatment plant reservoir at the top of the drumlin is operated

by the MWRA.

Because of the extensive land modification caused by more than 100 years of periodic construction activity on Deer Island, very little area on the island has been untouched. As a result, there are no pristine or mature habitats on the island or on its shores, and vegetation on the island consists mainly of weedy invasion species.

Nut Island

Information provided on the terrestrial ecology of Nut Island is based on a review of pertinent literature (Metcalf & Eddy, 1982).

Site Conditions. Nut Island is a small peninsula approximately 1,500 feet long and 500 feet wide (Figure 5.2.1-1). It consists of a substantially altered drumlin connected by a manmade causeway to a second drumlin on the mainland. The island is devoid of significant natural features; any that existed when the island was in its original condition were eliminated when the site was employed for the wastewater treatment plant, which now occupies the entire area. The limited peripheral open space on the island is maintained as cut grass.

Flora. Weedy forbs and managed grasses are the only plant life found on the island. No wildlife habitat is present other than perching places for occasional birds.

There are no wetlands on the island (USDI, 1987).

Fauna. Visiting gulls are the only evidence of wildlife found on Nut Island. Due to the high level of human activity on the island and the total lack of nesting and foraging areas, no other fauna of any significance are expected to use the island.

Endangered and Threatened Species. Because of the industrial nature of the site and the high level of human activity, no endangered or threatened species of any kind are expected at the Nut Island site (USDI, 1986).

Long Island

Information provided on the terrestrial ecology of Long Island is summarized from a review of pertinent literature (Metcalf & Eddy, 1982).

Site Conditions. Figure 5.2.1-3 shows the existing conditions on Long Island. Long Island comprises an area of 213 acres. Physical changes to Long Island consist of the Chronic Disease Hospital, located on approximately 60 acres on the north-central portion of the island, abandoned military installations, localized areas of fill along roadways, and a pier and sea walls located on the northwest portion.

The dominant topographic and geologic features on Long Island are the drumlins, which stand at an elevation of about 90 feet above the surrounding low land areas. A main drumlin forms the

central part of the island, while the head of the island consists of a drumlin smaller in land area but slightly higher in elevation than the main drumlin. The eroded remnants of two more drumlins are visible at the southwest end of the island.

The shoreline of Long Island is primarily a narrow, rocky beach, with relatively steep or walled embankments around much of its perimeter. Most of the flatter beach areas occur in the southern portion of the island and extend from marshes inland to tidal mudflats offshore. Marsh areas adjacent to the shoreline are noted on Figure 5.2.1-3. Two freshwater marshes occupy the low area along the western shore, adjacent to an abandoned Nike base; a small saltmarsh area is located on the east side of the island at Bass Point opposite the Nike site.

Flora. The wooded slopes of the drumlin at Long Island Head support a grass-sumac community characterized primarily by dense thickets of staghorn sumac (Rhus typhina). In addition, scattered specimens of apple (Pyrus malus), poplar (Populus sp.), white oak (Quercus alba), and red pine (Pinus resinosa) were observed in a March 1981 site visit (Metcalf & Eddy, 1986). The open areas of the central portion of the island exhibit various ornamental and shade tree plantings within the hospital grounds. West Head, as the southwestern tip of Long Island, supports a significant stand of mature red pine and shrubs. The area between the hospital and West Head is dominated by an extensive staghorn sumac community, with scattered stands of red pine, quaking aspen (Populus tremuloides), and cherry (Prunus sp.). A grove of mature elm trees (Ulmus americana) surrounds the cemetery in the mid-portion of the island. In the salt marsh area on the eastern side of the island, common reed (Phragmites communis) is the characteristic vegetation.

Fauna. The dense sumac thickets on the island provide an excellent habitat for cottontail rabbit, skunks, raccoons, squirrels, various rodents, and numerous birds. The marsh areas serve as feeding and nesting areas for resident and migrating waterfowl (ducks, geese, and brant). One of two nesting colonies of common terns (Sterna hirudo) observed in Boston Harbor is located on the abandoned piers at the northwest end of Long Island (Hatch, 1987).

The tidal flats along the shore of the island are an important shellfish habitat, with soft-shelled clams (Mya arenaria) being particularly productive along the western shore. Refer to Section 5.2.3 for a characterization of shellfishing within Boston Harbor and Quincy Bay.

Section 5.2.2 References

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5.2.3 EXISTING MARINE ENVIRONMENT

The following description of the marine environment in Quincy Bay is derived primarily from a review of existing literature and has been supplemented by the results of chemical and physical analyses performed on sediment samples located along the alternative inter-island transport system route.

Description of Quincy Bay

The Massachusetts Division of Marine Fisheries (MDMF) conducted a study of the marine resources of Quincy Bay in 1966. Although this study is dated, it provides a comprehensive overview of the ecological resources of the bay. This information has been supplemented with current data, where available.

Quincy Bay is a coastal bay that resembles an open ocean system, in that little dilution of ocean water takes place in the bay due to a lack of freshwater drainage (Jerome et al., 1966). The bottom sediments consist largely of organic-rich silts of recent deposition, overlying a layer of Pleistocene marine clay and glacial drift of variable thickness. Associated with the clay are sands and gravel. Bedrock consists of Carboniferous argillite (a dark blue slaty rock), tillite (a conglomerate-like rock thought to originate from glacial till), and Conglomerate rock (Jerome et al., 1966).

The total volume of water contained within the Bay is 7.57 billion ft^3 at mean high water with a maximum surface area of 7,772 acres. The percentage of change in volume between high and low tides is about 38 percent (Jerome et al., 1966).

Water Quality

Water quality sampling in Quincy Bay has been conducted by MDMF and by the Division of Water Pollution Control (DWPC). Data from these surveys are summarized in Table 5.2.3-1.

In general, the waters of Quincy Bay are typical of coastal areas. As shown on Table 5.2.3-1, surface water temperatures of the bay vary seasonally, ranging from 0 to 22 degrees. Salinities are generally high (between 32 and 35 ppt) ranging from around 27 to 40 ppt, reflecting the lack of freshwater input. Dissolved oxygen at the surface ranges from 6.0 to 10.0 + ppm, and pH remains relatively constant throughout the year at about 7.8 to 8.2 (Jerome et al., 1966; DWPC, 1985). Water transparency, as measured by secchi disk, ranges from 2 to 15 ft, depending on the season and meteorologic conditions.

With regard to nutrients, total Kjeldhal nitrogen and ammonium nitrogen range from 0.48 to 2.0 mg/l and <0.01 to 0.38 mg/l, respectively. Total phosphorus ranges from 0.03 to 0.30 mg/l. Suspended solids generally range between 3.5 and 32 mg/l, indicating average conditions (Table 5.2.3-1).

TABLE 5.2.3-1

SUMMARY OF WATER QUALITY DATA
QUINCY BAY

Location	Temperature (oC)	Salinity (o/??)	D.O. (ppm)	pH	Transparency (ft)	Suspended Solids (mg/l)	Total K. (mg/l)	NityN (mg/l)	Total Phosphorus (mg/l)	Reference
Quincy Bay										
Station 12	18.1-21.4	35-36	6.2-7.8	8.0-8.2	3.6-7.8	20-32	1.1-1.7	.02-.05	.12-.15	MDWPC 1983
" 12A	18.1-22.0	34-38	6.1-7.9	8.0-8.2	3.9-9.8	17-29	1.2-1.6	.01-.06	.11-.16	
" 13	16.-21.0	32-37	7.3-7.9	8.0-8.2	6.6-7.5	19-26	.99-1.5	.01-.14	.11-.14	
Quincy Bay										
Station 12	12.6-22.0	34-40	6.1-8.9	7.7-8.1	8.6-8.5	6.5-27	0.89-1.9	.05-.39	.10-.23	MDWPC 1984
12A	12.6-22.0	34-39	7.7-8.9	7.7-8.1	2.9-6.6	6.5-14	0.70-2.0	.02-.33	.11-.30	
13	11.5-21.4	34-38	6.7-8.1	7.5-8.1	3.2-9.8	5.5-27	0.86-1.7	.04-.37	.09-.26	
13A	12.1-22.0	34-38	6.4-9.0	7.7-8.1	5.2-8.5	7.5-27	0.76-2.0	.04-.38	.09-.23	
Quincy Bay										
Station 12	14.8-20.6	29.-32.7	7.5-10.1	7.4-8.2	--	6.0-21	.51-1.6	<.01-.21	.03-.25	MDWPC 1985
12A	15.2-20.6	29.-32.6	6.7-9.4	7.6-8.2	--	8.2-19	.48-1.3	.01-.35	.03-.26	
13	14.9-18.9	29.2-32.8	6.9-9.4	7.6-8.1	--	3.5-18	.58-1.3	.01-.36	.04-.25	
13A	14.4-18.9	30.0	7.3-8.5	7.8-8.1	--	3.5-18	.73-.93	.02-.10	.04-.16	
Quincy Bay										Jerome et al 1966
Long Island (S?)	020°	27.5-33.0	6.0-10.0+	5.0-8.0	2-15					
Long Island Bridge	4-14	29.5-32.0								
Nut Island West	2.1-20°	27.5-32.0	9.0-10.0+	8.0-8.5	3.515					
Pemberton Point	0-19.6	30.0-35.0	9.0-10.0+	8.0-8.5	6-15					

Marine Ecology

Historically, finfish, shellfish, and lobsters were available in quantity to the settlers of the Quincy Bay area. Today the recreational and commercial use of the marine resources of the bay have been seriously affected by pollution.

Data on the marine resources of Quincy Bay are derived primarily from studies conducted by Jerome et al. (1966).

Benthos

The benthic community in Quincy Bay is generally dominated by tube-building polychaete worms. No specific studies relating to the composition or abundance of the infaunal assemblages have been conducted to date. However, infaunal associations would be expected to be similar to those elsewhere in Boston Harbor, depending on the substrate (e.g., sand, silt, clay). Jerome et al. (1966) identified mud worms (*Phascolosomas gouldii*), blood worms (*Glycera dibranchiata*), and the clam worm (*Nereis virens*) from intertidal areas within the bay.

The pollutant-tolerant polychaete worm, *Polydora ligni*, predominates throughout much of Boston Harbor. *Capitella capitata*, another species adapted to enriched organic sediments, is also present (NEA, 1975). Polychaete worm populations within the harbor have occurred at densities greater than 200 per ft^2 , a level indicative of excessive enrichment. Both of these species would be expected to occur in Quincy Bay, particularly in areas of sedimentation, as a result of the Nut Island outfall.

Surface sediments from the northeastern side of Nut Island were taxonomically examined as part of a study in 1986 to evaluate the ecological acceptability of dredged material from Deer Island and Nut Island for ocean disposal (ERCO, 1986). Surface sediments from Nut Island were generally dominated by *Streblospio benedicti*, a sedentary polychaete worm belonging to the *Spionid* family. *Spio* sp. was the next most abundant species, followed by *Spio setosa* (Table 5.2.3-2).

In addition to the infaunal species noted above, a variety of other bottom-dwelling organisms are present in Quincy Bay. These include shellfish such as the soft-shelled clam (*Mya arenaria*), the hard-shelled clam or quahog (*Mercenaria mercenaria*), and the edible mussel (*Mytilus edulis*), and crustaceans such as the lobster (*Homarus americanus*), the rock and Jonah crabs (*Cancer irroratus* and *C. borealis*), the green crab (*Carcinides maenas*), and arthropods such as the horseshoe crab (*Limulus polyphemus*) (Table 5.2.3-3).

Finfish

Finfish sampling reported by Jerome et al. was conducted in Quincy Bay at several shore and offshore sampling stations. A total of 27 species were collected. The most abundant species collected at the shore stations by minnow seine were Atlantic silverside (*Menidia menidia*), mummichog (*Fundulus heteroclitus*), threespine stickleback (*Gasterosteus aculeatus*), fourspine

TABLE 5.2.3-2

BENTHIC COMMUNITY PROFILE OF

NUT ISLAND SEDIMENT

Species Name	Number of organisms per liter of sediment
Streblospio benedicti	26
Spio (sp.)	8
Nephtys caeca	1
Campanularis gelatinuosa	a
Nassarius trivitatus	1
Ampelisca abdita	1
Cirratulidae	1
Spio setosa	4
Spiophanes bombyx	1

Source: ERCO. 1986. Ecological evaluation of proposed Oceanic discharge of dredged material from Deer Island and Nut Island. Draft Final Report, Prepared for C.E. Maguire Inc. and Havens and Emerson, June, 26p.

stickleback (Apeltes quadracus), winter flounder (Pseudopleuronectes americanus), and striped killifish (Fundulus majalis) (Table 5.2.3-4). At the offshore stations, the most abundant species collected by otter trawl included winter flounder, Atlantic cod (Gadus morhua), and winter and little skates (Raja ocellata and R. erinacea). Two other species, taken by hook and line, included menhaden (Brevoortia tyrannus) and mackerel (Scomber scombrus) (Table 5.2.3-4).

Commercial and Sport Fisheries

Commercial finfisheries are restricted by regulations prohibiting beam or otter trawling in all but a small portion of Quincy Bay. Nonetheless, two species, menhaden and winter flounder, have been taken in quantities sufficient to support a fishery of commercial importance.

The bulk of the sport fishery effort in Quincy Bay is expended on winter flounder and mackerel. The winter flounder fishery begins in April and continues through the fall months. Mackerel generally arrive in the area in late spring or early summer.

Cod and, formerly, striped bass, also contributed to the sport fishery. Cod are generally fished in the late winter and spring. Striped bass are no longer plentiful in the area.

Shellfish

The soft-shelled clam is the only abundant commercially valuable shellfish species present in Quincy Bay. Many of the intertidal flats in the bay provide suitable habitat for soft-shelled clams; however, many of the flats within the bay are closed to harvesting due to gross contamination from wastewater.

Long Island has the largest, most productive, and most accessible clam flats in Quincy Bay. The flats, which lie on the southeastern side of the island where the substrate is composed of fine to medium sand, mud, and stones, are all closed to harvesting because of bacterial contamination of overlying waters. The flats along Wollaston Beach, Peddock's Island, Rainsford Island, and the northwest side of Moon Island are also closed to harvesting because of bacterial comtamination or their proximity to sources of pollution (EPA, 1984).

In addition to the soft-shelled clam, the edible blue mussel is also abundant in Quincy Bay, although not considered to be commercially valuable. Large populations of mussels are present on rocks or attached to hard substrates in the upper intertidal areas. Other shellfish in the bay include the duck clam (Macoma sp.), occasionally the hard-shelled clam or quahog (Mercenaria mercenaria), oyster drills (Urosalphinx cinera), and gem shells (Gemma gemma) (Table 5.2.3-3).

Marine Macroflora

An inventory of the marine plant life associated with Quincy Bay was conducted by Jerome et al. (1966). A total of 23 species of algae and vascular plants were identified (Table 5.2.3-5).

TABLE 5.2.3-3

BENTHOS OF
QUINCY BAY

Common name	Scientific name	Comment
Soft-shelled clam	*Mya arenaria*	Commercially valuable
Hard-shelled clam	*Mercenaria mercenaria*	Occasional
Edible blue mussel	*Mytilus edulis*	Abundant
Oyster drill	*Urosalphinx cinera*	Occasional
Duck clam	*Macoma* sp.	Common
Gem shells	*Gemma gemma*	Common
Lobster	*Homarus americanus*	Commercially valuable
Rock crab	*Cancer irroratus*	Commercially valuable
Jonah crab	*Cancer borealis*	Commercially valuable
Green crab	*Carcinides maenas*	Common
Horseshoe crab	*Limulus polyphemus*	Common

TABLE 5.2.3-4

FINFISH SAMPLING DATA,
QUINCY BAY

Common name	Scientific name	Occurrence
Atlantic silverside	Menidia menidia	Abundant
Atlantic tomcod	Microgadus tomcod	Common
Mummichog	Fundulus heteroclitus	Abundant
Smelt	Osmerus mordax	Common
Threespine stickleback	Gasterosteus aculeatus	Abundant
Blueback herring	Alosa aestivalis	Common
Spiny dogfish	Squalus acanthias	Common
Winter flounder	Pseudopleuronectes americanus	Abundant
Fourspine stickleback	Apeltes quadracus	Common
Striped killifish	Fundulus majalis	Common
American sand lance	Ammodytes americanus	Common
Ninespine stickleback	Pungitius pungitius	Common
American eel	Anguilla rostrata	Common
Lumpfish	Cyclopterus lumpus	Common
Silverhake	Merluccius bilinearis	Common
Northern pipefish	Syngnathus fuscus	Common
Winter skate	Raja ocellata	Abundant
Little skate	Raja erinacea	Abundant
Atlantic cod	Gadus morhua	Abundant
Striped bass	Morone saxatilis	Occasional
Sea raven	Hemitripterus americanus	Common
Longhorn sculpin	Myxocephalus octodecemspinosus	Abundant
Ocean pout	Macrozoarces americanus	Abundant
Windowpane flounder	Scophthalamus aquosus	Common
Yellowtail flounder	Limanda ferruginea	Common
Menhaden	Brevoortia tyrannus	Occasional
Mackerel	Scomber scombrus	Occasional

Source: Jerome et al. 1966

TABLE 5.2.3-5

MARINE FLORA OF QUINCY BAY

Common name	Scientific name	Classification
Marine Algae		
Green hollow tube	Enteromorpha intestinalis	Chlorophyceae
Sea lettuce	Ulva lactuca	Chlorophyceae
Irish moss	Chondrus crispus	Rhodophyceae
Sea oak	Phycodrys rubens	Rhodophyceae
Dulse	Rhodymenia palmata	Rhodophyceae
Laver	Porphyra umbilicalis	Rhodophyceae
Mermaid's hair	Polysiphonia spp.	Rhodophyceae
	Halosaccion sp.	Rhodophyceae
	Lomentaria clavellosa	Rhodophyceae
Sea colander	Agarum cribrosum	Phaeophyceae
Knotted wrack	Ascophyllum nodosum	Phaeophyceae
Rockweed	Ascophyllum mackaii	Phaeophyceae
Devil's shoelace	Chorda filum	Phaeophyceae
Rockweed	Fucus vesiculosus	Phaeophyceae
Rockweed	Fucus spiralis	Phaeophyceae
Southern kelp	Laminaria agardhii	Phaeophyceae
Finger kelp	Laminaria digitata	Phaeophyceae
Kelp	Laminaria saccharina	Phaeophyceae
	Petalonia fascia	Phaeophyceae
	Punctaria latifolia	Phaeophyceae
Vascular Plants		
Saltwater cord-grass	Spartina alterniflora	
High water cord-grass	Spartina patens	
Widgeon grass	Ruppia sp.	

Source: Jerome et al. 1966

Marsh areas such as the one along Squantum's Mason Point were dominated by saltwater cordgrass (Spartina alterniflora and S. patens). Total salt marsh habitat in 1964 in Quincy Bay was 209 acres. Squantum Marsh contained 95 acres, while Black's Creek Marsh contained 114 acres. Widgeon grass (Ruppia sp.) was also present.

With respect to marine algae, 2 species of green algae (Chlorophyceae), 7 species of red algae (Rhodophyceae), and 11 species of brown algae (Phaeophyceae) were identified from Quincy Bay (Table 5.2.3.-5). The shore stations at Long Island, Quincy Bay Marina, and Pemberton Point were essentially devoid of attached vegetation within the intertidal zone with the exception of small patches of rockweed (Fucus spp.) and knotted wrack (Ascophyllum spp.).

Other noteworthy species included sea lettuce (Ulva lactuca), Enteromorpha intestinalis, Irish moss (Chondus crispus), sea oak (Phycodrys rubens), dulse (Rhodymenia palmata), laver (Porphyra umbilicalis), tubed weeds (Polysiphonia spp.), sea colander (Agarum cribrosum), and kelps (Laminaria spp.) (Table 5.2.3-5)

Environmental Stresses

Without a doubt, the primary environmental stress within the Quincy Bay marine system is pollution. Samples of the water column and sediments show pollution in the form of coliform bacteria, heavy metals, pesticides, PCBs, and polycyclic aromatic hydrocarbons (PAHs) (DWPC, 1985; ERCO, 1986; DWPC, 1984; DWPC, 1983; Boehm et al., 1984). The closure of shellfish areas due to pollution has restricted the use of the productive soft-shelled clam habitat in the bay with resultant economic loss.

Water column chemistry data taken by the Massachusetts DWPC from sampling stations in Quincy Bay generally show metals at concentrations near the limits of detection. In some cases, the detection limit is above the EPA average and/or maximum criteria concentration value for the protection of saltwater aquatic life. Thus, determination of the exceedance of maximum criteria concentrations (MCCs) is equivocal in many instances. Wallace at the University of Massachusetts, Boston, using analytical methods with lower detection limits than the DWPC, has shown that for zinc, lead, cadmium, and nickel, the EPA average criteria concentration values are not exceeded (DWPC, 1985). Copper is an exception, and concentrations in the harbor exceedthe chronic and acute criteria values of 0.002 and 0.0032 ppm, respectively, ranging from 0.0035 to 0.0050 ppm.

Boston Harbor sediments have generally been found to contain high concentrations of heavy metals, PAHs, and moderate concentrations of PCBs. Heavy metal concentrations in Quincy Bay range from 0.02 mg/kg for a low for mercury to a high of 840 mg/kg for lead (ERCO, 1986) (Table 5.2.3-6).

Boehm et al. (1984) conducted a study of the organic pollution (PCB, PAH, and coprostanol) contamination in Boston Harbor, Massachusetts Bay, and Cape Cod Bay sediments and biota. Two of the sampling stations were located in Quincy Bay (stations BH-4 and BH-5). Sediments at station BH-4, located south of Moon Island at a depth of 6 m, consisted of black ooze/mud and shells. Station BH-5, located northeast of Peddock's Island at a depth of 8 m, consisted of

TABLE 5.2.3-6

QUINCY BAY SEDIMENT CHEMISTRY DATA

Station	Metals (mg/kg drt wt)												
	Ag	Zn	As	Cr	Pb	Cu	Ni	Cd	Th	Se	Al	Hg	Reference
12	3.0	165	53	50	60	90	20	2.0	<5.0	<0.5	--	--	MDWPC 1985
12A	1.0	180	9.4	150	145	120	20	1.5	<5.0	<0.5	--	--	
13A	1.5	135	18	175	135	95	26	1.5	--	--	20,600	--	
Nut Island East Side													
1		210	8.6	26	840	210	18	0.33	--	--	--	0.25	
2	--	43	4.1	24	8.5	11	14	0.34	--	--	--	0.02	ERCO 1986
3	--	170	4.4	28	15	15	15	0.32	--	--	--	0.097	
4	--	130	4.6	57	93	50	15	0.60	--	--	--	0.67	
5	--	48	4.7	32	13	14	16	0.37	--	--	--	0.032	
6	--	230	4.0	34	15	16	15	0.40	--	--	--	0.072	

Organics

	PAH (ug/g)	FFPI	PCB (ng/g)	Coprostanol	Total Organic Carbon (mg/g)	Reference
BH-4	6.5 + 2.0	23 + 6.2	330 + 119	1.2 + 0.2	41.5 + 11.9	BOEHM ET AL., 1984
BH-5	6.0 + 1.3	46 + 5.3	100 + 23.7	6.2 + 1.5	23.5 + 4.7	

	PCB 1260	Fluoroanthene	Phenanthrene	Pyrene	Chrysene	Benzoanthracene	
12	0.27	0.10	0.10	0.10	--	--	DWPC 1985
12A	0.44	N.D.	0.10	N.D.	--	--	
13A	--	--	0.10	--	<0.10	<0.10	

N.D. = Not Detected

soft brown mud. Station BH-4, in particular, showed unusually high levels of PCBs (330 + 119 ng/g) (Table 5.2.3-6). This station also had the highest organic carbon loading (about 4 percent), reflecting the contribution from the Nut Island treatment facility and CSOs. The concentration of PCBs in Quincy Bay is almost 2.5 times higher than the mean (about 140 ng/g) for Boston Harbor.

With respect to the distribution of PAHs, Boston Harbor sediment appears to be patchy, with values ranging from 2.4 to 880 ug/g (X= 180 ug/g). The Quincy Bay stations BH-4 and BH-5 exhibited concentrations of PAHs of 6.5 and 6.0 ug/g, respectively. The fossil fuel pollution index (FFPI) as developed by Boehm reflects the related input of fossil PAH (petroleum, coal) to combustion PAH (products of fossil fuel combustion and urban air particulates). Petroleum PAH compounds are thought to be more readily available to marine organisms than combustion-related PAH. FFPI values at BH-4 indicate primarily combustion PAH, while those at BH-5 are equally split between the two basic types of PAH.

Concentrations of the wastewater tracer, coprostanol, within Quincy Bay are relatively high, although not as high as concentrations found at BH-2, just west of Deer Island. Values for stations BH-4 and BH-5 were 1.2 and 6.2 ug/g, respectively, compared with 15.9 ug/g for BH-2. When compared with levels elsewhere in Boston Harbor, however, it appears that the levels in Quincy Bay are the result of the presence of the Nut Island treatment facility and CSOs.

With respect to the levels of contaminants within biota, Boehm et al. determined that the levels of PCBs and PAHs in finfish from Boston Harbor are quite low. Levels in cancer crabs (Cancer sp.), however, are much higher, but still an order of magnitude lower than FDA action levels (Table 5.2.3-7).

For the secondary facilities planning project, sediment samples taken from three locations between Nut Island and Long Island were analyzed to determine chemical and physical characteristics in accordance with the Massachusetts DWPC criteria for evaluation of dredge material. The locations of the sediment samples shown in Figure 5.2.3-1 were placed along a route between Nut Island and Long Island that was considered for an alternative pipeline or sunken tube interisland wastewater conduit. The results of the analyses performed on both surface sediment grab samples (i.e., the top two cm of sediment) and on composited core samples are summarized in Table 5.2.3-8. These results indicate that the sediment samples can be characterized as type 1A, 1B, or 2B, in accordance with the criteria of 314 CMR 9.03. The criteria for these samples would allow for the disposal of dredged material in the foul area designated by the U.S. Army Corps of Engineers, provided that subsequent bioassay testing does not indicate a significant biological impact.

Summary

Quincy Bay is a coastal bay that resembles an open ocean system. Water quality in the bay is generally typical of coastal areas. There is, however, considerable organic enrichment as a result of the presence of the Nut Island treatment facility and existing CSOs.

TABLE 5.2.3-7

FDA ACTION LEVELS FOR
FISH AND SHELLFISH

Substance	FDA Action Level
PCB	2.0 ppm
Aldrin	0.3 ppm
Dieldrin	0.3 ppm
Chlordane	0.3 ppm
DDT, DDE, TDE	5.0 ppm
Endrin	0.3 ppm
Heptachlor	0.3 ppm
Heptachlor epoxide	0.3 ppm
Kepone	0.3 ppm
Methyl mercury	1.0 ppm
Mirex	0.1 ppm
Toxaphene	5.0 ppm

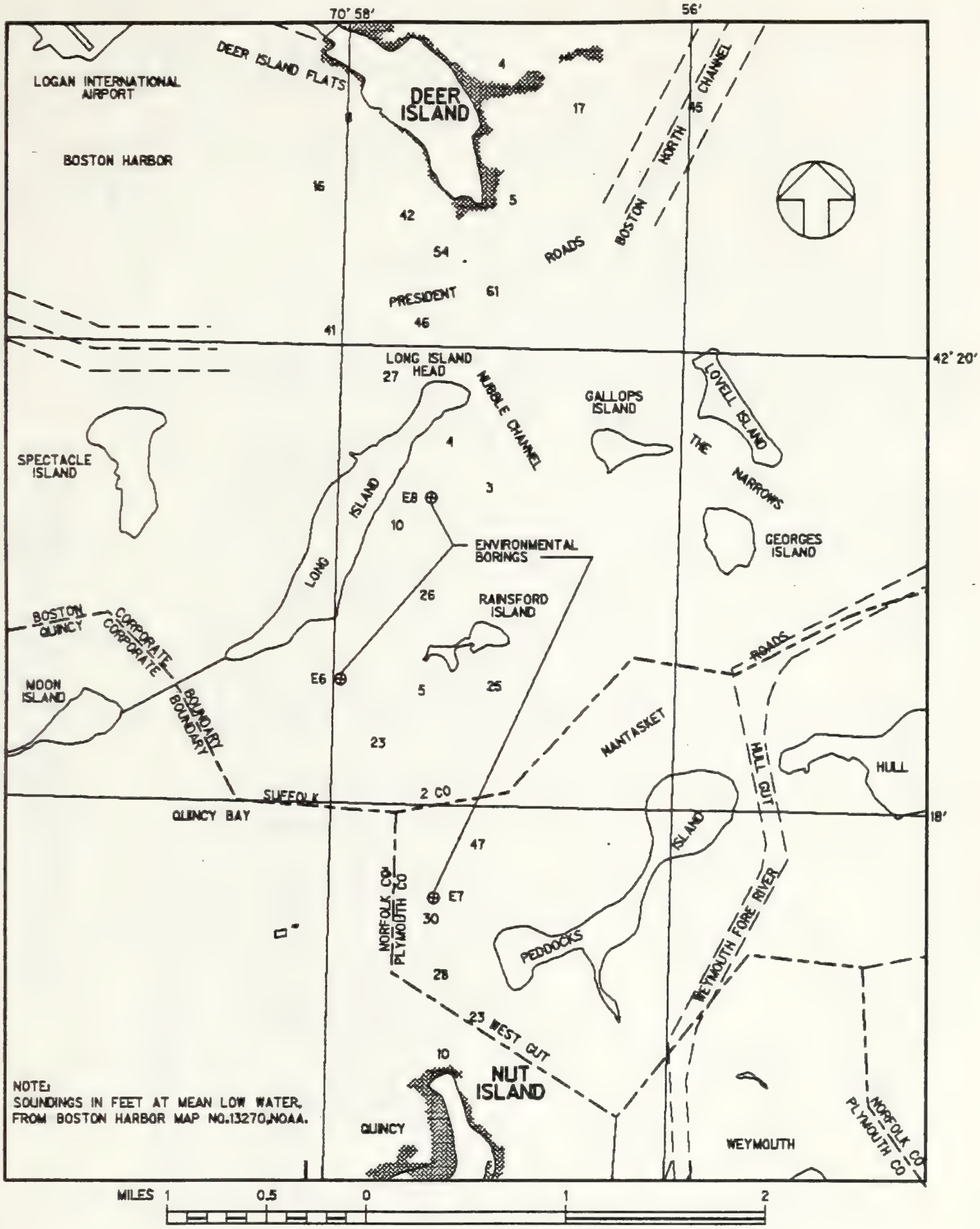

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FIGURE 5.2.3-1
INTER-ISLAND SEDIMENT SAMPLING LOCATIONS

TABLE 5.2.3-8

RESULTS OF CHEMICAL/PHYSICAL ANALYSES
PERFORMED ON SEDIMENT SAMPLES

Sample	Depth*	Metal concentrations, mg/g									Silt-clay, %	Water %	Volatile solids, %	Oil grease, mg/g	Total PAH, mg/g
		As	Cd	Cr	Cu	Hg	Ni	Pb	V	Zn					
E6	SURF	8.93	<3.06	244.39	104.59	1.265	32.14	139.29	55.10	142.86	69.72	54	7.1	0.000	3.938
E6	3'6"	13.56	<2.70	86.04	52.70	0.473	33.78	54.95	77.03	118.02	81.76	33	4.1	0.056	3.626
E7	SURF	7.04	<3.70	92.59	55.56	0.506	19.14	50.00	58.64	98.15	27.39	41	4.5	0.228	1.880
E7	4'9"	6.25	<3.00	65.00	32.00	0.100	35.00	12.50	82.50	96.00	70.38	25	2.9	0.018	1.075
E8	SURF	4.32	<2.16	96.04	48.20	0.586	14.39	68.71	30.94	74.82	33.74	42	3.9	0.078	3.522
E8	4'3"	4.27	<2.91	23.79	9.22	0.107	12.62	9.22	25.73	40.29	52.92	35	2.9	0.075	0.474

* Depth of sediment core sample

The marine biological communities are also typical of coastal systems. Species composition and abundance of benthic organisms, finfish, shellfish, and macroinvertebrates are similar to those elsewhere in Boston Harbor. Excessive organic enrichment and pollution from coliform bacteria, heavy metals, PCBs, and PAHs occur in the water column and sediments of Quincy Bay. Many of the productive soft-shelled clam flats in the bay have been closed to harvesting due to gross contamination from wastewater.

Section 5.2.3 References

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5.2.4 NOISE

Noise associated with the construction and operation of the new Deer Island secondary wastewater treatment plant and the headworks facilities on Nut Island has the potential for affecting portions of the Town of Winthrop and the City of Quincy. To minimize noise impact, noise control requirements will be incorporated into the treatment plant facilities planning process through the use of noise evaluation criteria. These criteria will be employed to judge the effectiveness and acceptability of noise controlling alternatives as they apply to wastewater treatment equipment, site planning, and construction. The existing regulatory and environmental factors that constitute the basis for developing the noise evaluation criteria are summarized in this section.

Regulatory criteria that address noise control, as well as assessments of potential impacts, rely on evaluations of baseline noise levels for judging the magnitude and acceptability of incremental noise changes. Several baseline noise surveys have previously been made in the Point Shirley and Nut Island study areas. These surveys sampled ambient noise for periods of a few minutes up to 24 hours.

This section characterizes existing noise in the study areas and describes a more extensive study conducted during this facilities plan to provide a firm statistical basis for the development of recommended noise criteria for Deer Island. The results of this and previous surveys and recommendations for construction and operational noise criteria are summarized herein.

Regulations and Guidelines

The assessment of noise impact involves determining both the increase in ambient noise and compliance with appropriate regulations. Three noise regulations are potentially applicable to the Deer Island site. These are the City of Boston noise regulations, the Massachusetts Department of Environmental Quality Engineering (DEQE) guidelines, and U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) standards. The latter two regulations are also applicable to Nut Island.

The City of Boston's noise regulations address various sources of noise and set specific noise limits for the transmission of sound between properties of the same and different zoning. The allowable noise transmitted to a residential zone during the daytime hours of 0700 to 1800 (7:00 a.m. to 6:00 p.m.) is 60 dBA. A 50-dBA level is allowable during the remaining nighttime hours. The maximum noise allowed to be transmitted to an industrial site is 70 dBA. The code also has corresponding octave band level requirements.

The Boston noise code limits construction noise at residential and institutional property lines to an L10 (the level exceeded 10 percent of the time) of 75 dBA and a maximum level of 86 dBA. The allowable L10 for recreational land is 80 dBA. Construction is not permitted at night or on weekends, unless the construction noise level at the residential property line does not exceed 50 dBA.

The State of Massachusetts Department of Environmental Quality Engineering (DEQE) guidelines on noise allow a new facility to increase the ambient noise a maximum of 10 dBA over the existing L90 ambient noise, i.e., the level exceeded 90 percent of the time. The L90 levels to be used are the lowest values measured at night. The DEQE guidelines also prohibit the emission of a pure tone from noise sources. A pure tone is defined as occurring when the level in one octave band exceeds the level in the two adjacent octave bands by 3 dB or more.

All equipment on the site will be required to conform to the OSHA requirement on noise exposure. The regulations allow an equivalent 8-hour exposure of 90 dBA for the protection of employee hearing. Where equipment cannot be purchased to meet OSHA noise exposure requirements, noise mitigation must be added as required.

Previous Ambient Sound Level Surveys

At least five previous ambient sound level surveys associated with the Deer Island treatment facilities have been conducted in the Deer Island area. These surveys are summarized in Table 5.2.4-1. The surveys collected statistical sound level samples of a few minutes to an hour in duration, and in one instance, 24 hours. Measurements were usually collected at several locations. These measurements were used for making preliminary assessments of anticipated noise impact for the facility.

As part of secondary treatment facility planning and environmental reviews, a more extensive data base was desired. Ambient noise is a statistical quantity that not only varies diurnally, but also from day to day. Both the perceived noise impact and the allowable level as required by the DEQE are based on an assessment of the existing ambient sound level. A sampling program that continuously monitored ambient sound levels 24 hours a day for a total of 17 days was conducted. This large sample of ambient sound levels provides a broad base for assessing the existing ambient levels.

At least two ambient sound level surveys have been conducted in the Nut Island treatment plant area. Since the amount of construction and operational noise sources planned for Nut Island is very small compared to that expected at Deer Island, the two existing noise surveys will be sufficient to assess the noise impact expected from the construction and operation of the facility.

Ambient Sound Level Surveys

For this study, an ambient sound level survey was conducted at Point Shirley, in the Town of Winthrop, as the nearest area potentially affected by facility construction and operation noise. The goals of the survey were to

1. Establish the spatial variation in the ambient sound levels throughout Point Shirley

2. Establish the diurnal variation in the sound levels

3. Determine the temporal variability of sound levels from day to day

TABLE 5.2.4-1

SUMMARY OF PREVIOUS AMBIENT SOUND LEVEL SURVEYS
CONDUCTED IN WINTHROP FOR THE WASTEWATER TREATMENT PLANT

Conducted by	Date	Reported in
Metcalf and Eddy	1982	Site Options Study, Vol II 1982.
Havens and Emerson	4-3-84	Supplemental Draft Environmental Impact Statement/Report on Siting of Wastewater Treatment Facilities for Boston Harbor, Vol. 2.
Thibault and Bubly Associates	6-12-85	Noise Analysis (To EPA).
Cavanaugh Tocci Associates	9-11-85 9-25-85	Supplemental Draft Environmental Impact Statement/ Report on Siting of Wastewater Treatment Facilities for Boston Harbor, Vol. 2, Appendix.
C.E. Maguire, Inc.	7-1-86	Notice of Project Change, On-Island Water Transportation Facilities, 7-31-86.

4. Identify the sources of noise controlling these levels

Measurement Locations and Methodologies

A preliminary inspection of the study area indicated that the primary noise sources were Logan Airport, traffic on Tafts Avenue and other local roads, surf noise from the beaches, and occasionally the existing treatment plant. Previous studies also indicated that the Nordberg diesel drives on the existing wastewater pumps were sometimes audible. These previous studies also assessed the sound levels throughout Winthrop and concluded that the mainland portion of Winthrop had nighttime L90 levels in the 34 to 40 dBA range, whereas Point Shirley was slightly louder, in the 40-43 dBA range. Since the distance to the other parts of Winthrop are greater, the criteria selected for Point Shirley will serve as conservative criteria for the balance of Winthrop.

Measurement locations were selected to provide data on each of the sources discussed in the previous paragraph, as well as to be spatially distributed across Point Shirley. A map of the locations is given in Figure 5.2.4-1. All of the locations except no. 1 have line-of-sight shielding by houses from the airport and surf. Location 1 was shielded by a house from the diesel pumping station. Locations 2 and 3 had line-of-sight visibility to the diesel pumping station.

Two types of noise survey methodologies were utilized, which, when used in conjunction with each other, provide a complete description of the spatial and temporal variation in sound levels. The first type consisted of the continuous statistical monitoring of sound level sequentially at locations 1 and 3, as shown in Figure 5.2.4-1. A total of 17 data days were taken sequentially at these locations. Locations close to the plant were selected for the continuous monitors because the potential for noise impact is greatest close to the site. The monitor was periodically calibrated throughout the survey.

The second type of survey was staffed, and measurements were taken with portable instrumentation. During these surveys, 10-minute statistical samples of sound level data were always taken; on three out of five of the surveys, residual octave band measurements were also taken. The staffed surveys enable a number of locations to be measured in a relatively brief period of time along with observations of the sources of noise. The staffed surveys were conducted during 2- to 3-hour periods during the day and night at locations 1, 2, 4, 5, 6, and 7. The staffed survey results are given in Appendix A, Tables A-1 through A-5.

Instrumentation

Two types of instruments were used for measuring the ambient sound levels. A Larson-Davis 800 noise analyzer and a Bruel and Kjaer 2215 sound level meter were used to manually measure residual octave band pressure levels and A-weighted sound level statistics. The residual octave band measurements were taken in the absence of transient noise such as passing vehicles and aircraft landings. Ten-minute statistical samples of the A-weighted sound level were taken by reading the meter every 10 seconds and preparing a histogram of the data. All manual

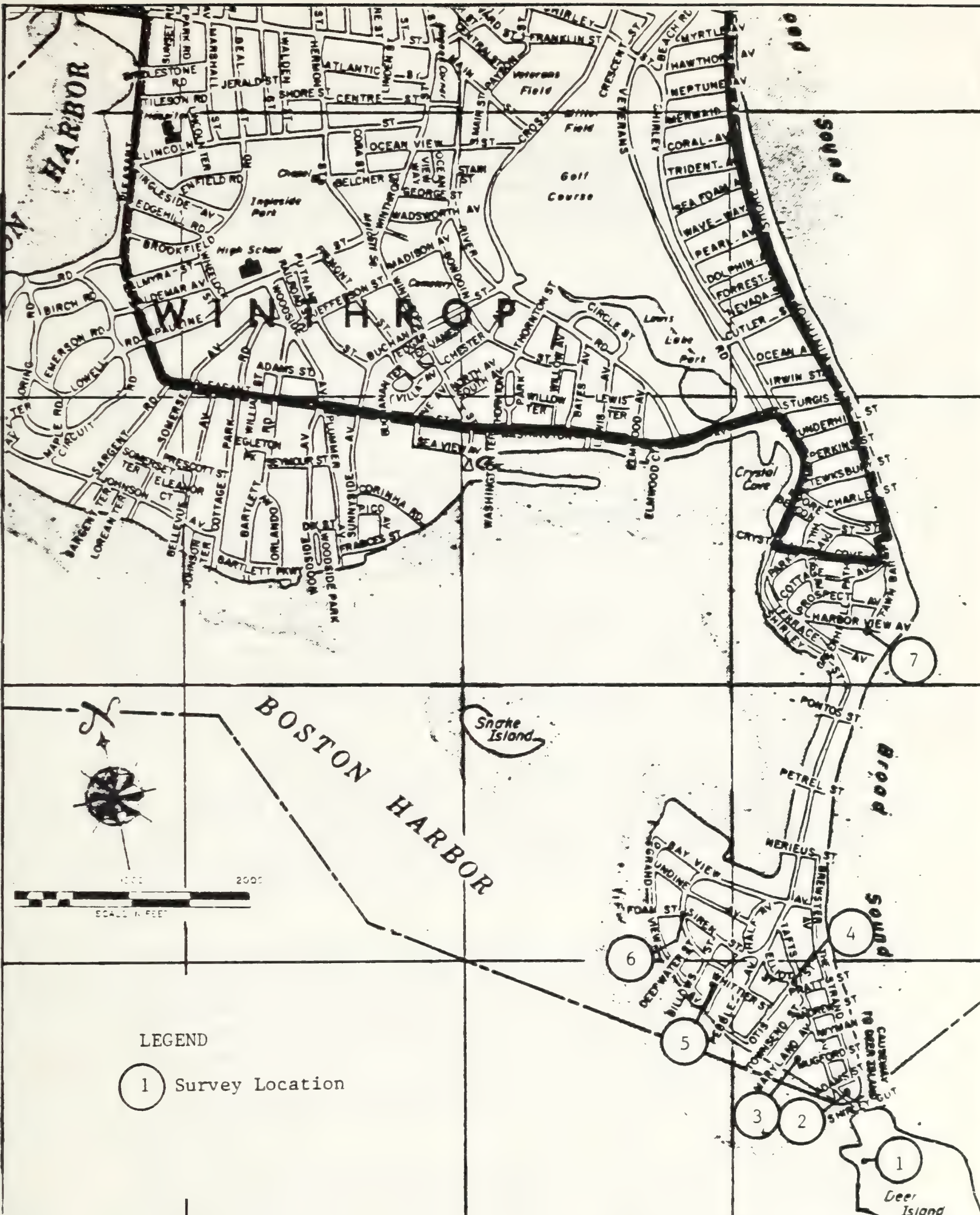

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FIGURE 5.2.4-1
AMBIENT SOUND LEVEL SURVEY MEASUREMENT POSITIONS, WINTHROP, MASSACHUSETTS, SEPTEMBER 1986

measurements were taken with local winds less than 10 mph.

The second type of instrument used was a Larson-Davis 700 noise dosimeter, which continually measures and statistically analyses the variable ambient noise. The device was programmed to provide hourly statistics including the L10, L50, and L90 values. The L90 value typically represents the residual or background level that occurs when transient noise is absent.

Survey Results and Discussion

Manually Collected Data. The manually collected data discussed for Point Shirley are presented in Appendix A, Tables A-1 through A-5. Most of the L90 sound level data taken some distance from the water (locations 4, 5, and 6) were determined to be in the 42 to 47 dBA range. Measurements taken from locations more exposed to surf noise, such as locations 1, 2, 3, and 7, were sometimes several decibels higher.

During the day and evening, the quiet intervals between aircraft takeoff and landing noise were observed to be infrequent and brief. However, after the hours of approximately 2300 to 2400 (11:00 p.m. to midnight), takeoffs and landings became infrequent and the residual levels appeared to be controlled by surface aircraft operations at Logan Airport, surf noise, and occasionally the Nordberg diesels of the treatment plant wastewater pumps.

In general, the more sheltered locations, away from the shore, were 5 to 6 dBA quieter than those near the water, because they were partially shielded from Logan ground operations, surf, and occasional diesel noise. This was directly observed in the field by measuring noise primarily from surface aircraft operations and then moving behind a house to block the line of sight to the airport.

The pumping station diesels were inaudible at all locations when the winds were northerly. This is because the vertical gradient in wind speed tends to raise the upwind sound wave off the ground and create a shadow zone. However, when the winds had a southerly component, from the direction of the diesels, the diesels were occasionally audible at one or two measurement locations, which varied from survey to survey. Diesel audibility is indicated in Appendix A, Tables A-1 to A-5.

When audible, the diesel sound varied in an irregular, pulsing manner caused by multiple diesel units operating at slightly different speeds. Most of the diesel noise was in the 63-Hz octave band corresponding to the cylinder firing rate. At one of the measuring locations, the diesels caused a 4-dBA variation in the sound level on "fast" response. The level in the 63-Hz band on "fast" response varied from 5 to 10 dB. On "fast" response, the meter's response time is reduced and the meter becomes very sensitive to rapid changes in sound level. All other measurements were taken on "slow" response as is standard practice for community noise measurements.

Continuous-Monitor Data. A tabulation of the data from the continuous monitor used first at location 1 and then at location 3 is given in Appendix B. This data describes the diurnal

variation in sound level for 13 days at location 1, and 5 days at location 3. The data from the two locations are similar and are analyzed together.

The L90 data were divided into meaningful time periods and sorted to examine the group statistics. The L90 sound levels for the nighttime period of 2300 to 0600 (11:00 p.m. to 6:00 a.m.) were grouped together and sorted to determine their percentiles of exceedence. During this period of time, it is likely that a significant percentage of the population is sleeping.

This analysis indicates that, during 50 percent of the time, the nighttime L90 values were greater than 45 dBA, indicating that 45 dBA is a typical value for the nighttime L90 sound level. The 90-percentile value of the L90 sound level at that location exceeds 39 dB. The lowest hourly L90 measured was 35 dBA at location 1.

A similar analysis was performed for the daytime hours of 0700 to 1800 (9:00 a.m. to 6:00 p.m.). This time period includes the most common periods of construction. The quietest hour during this period was at 41 dBA. However, 90 percent of the time the L90 levels were in excess of 45 dBA, and 50 percent of the time they exceeded 51 dBA. These measurements generally agree with the previous shorter-term assessments on noise on Point Shirley.

As indicated above, two ambient sound level surveys have been conducted in the vicinity of Nut Island. Because the construction and operation of new facilities at this location will be modest compared to Deer Island, additional surveys were not required.

The first noise survey was conducted on July 12, 1984 by C.E. Maguire, and reported in the SDEIR. The second survey was also conducted by C.E. Maguire and reported in their pile driving analysis. A map of the ambient measurement locations for both surveys is given in Figure 5.2.4-2 and a summary of the data is tabulated in Tables 5.2.4-2 and 5.2.4-3.

The L90 sound levels from the July 1984 survey were 52 and 54 at measurement locations 4 and 5, respectively. The L90 sound level was again measured on July 1, 1986 in the morning and in the afternoon at 49 and 47 dBA, respectively. The sampling period was 20 minutes.

Recommended Criteria

Two noise assessment criteria are required: one for assessing the noise from daytime activities such as construction and operation of the facility and one for assessing the nighttime operation of the facility. These criteria differ because the ambient sound level changes from day to night.

The nighttime L90 sound level is generally used to assess nighttime noise impact. However, when a large sample of L90 is collected, it becomes necessary to statistically select a representative L90 value. To be conservative, the 90-percentile value of the nighttime L90 values was selected for assessing nighttime noise impact. In other words, 90 percent of the nighttime L90 values exceed this value.

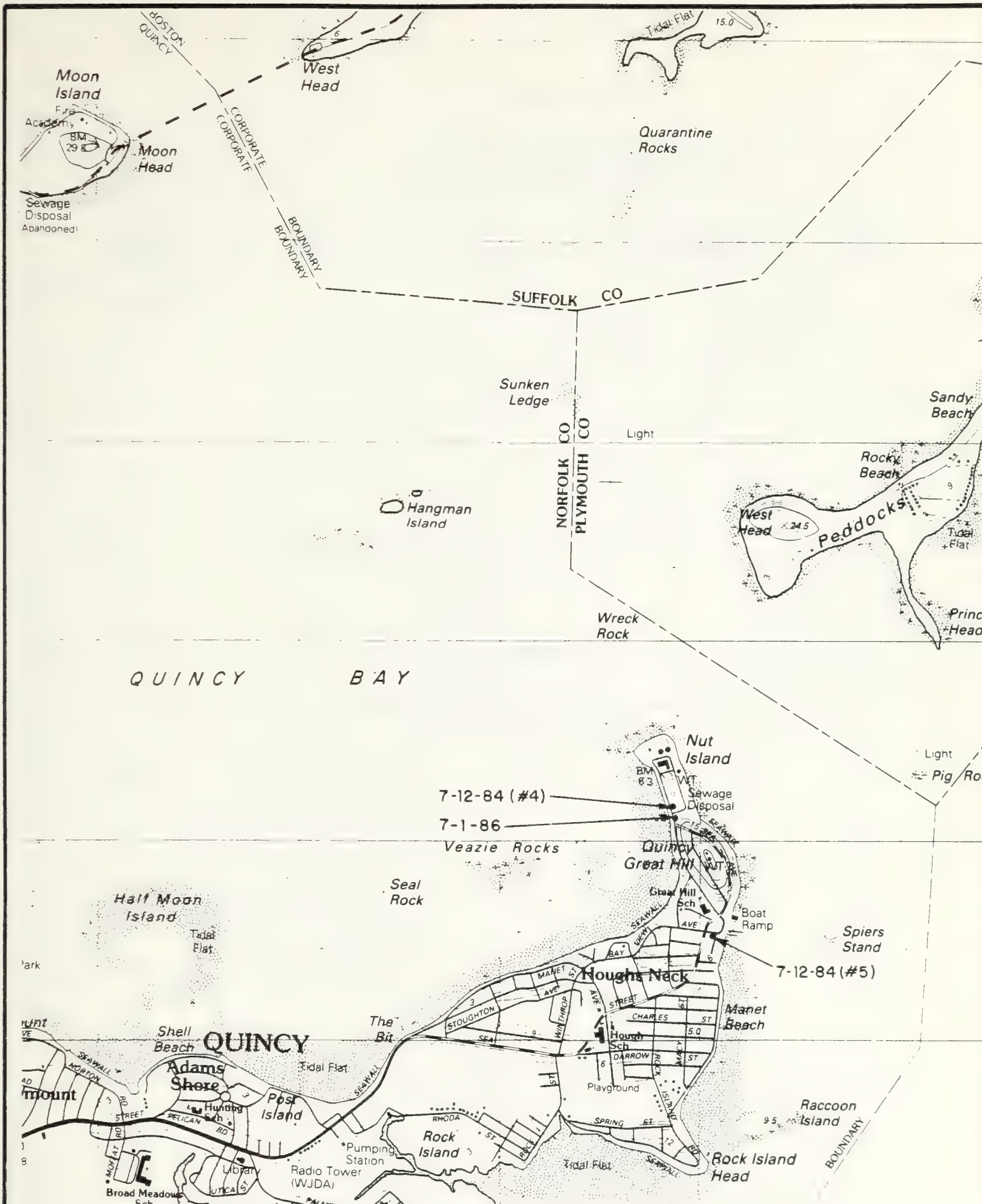

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FIGURE 5.2.4-2
DAYTIME BACKGROUND NOISE SAMPLING LOCATIONS ON NUT ISLAND

TABLE 5.2.4-2

AMBIENT NOISE LEVELS IN THE VICINITY OF NUT ISLAND, 1986

Project location	Noise metric	Start time	Current measurements	Start time
Nut Island	L90	10:38 a.m.	49	
	L10		53	
	Leq		52	
	L90	2:45 p.m.	47	1:30 p.m.
	L10		55	
	Leq		56	

Source: From pile driving analysis, C.E. Maguire to MWRA, 7-14-86

TABLE 5.2.4-3

AMBIENT NOISE LEVELS IN THE VICINITY OF NUT ISLAND(a)

SITE		L10	L50	L90	Leq
1.	Houghs Neck Nut Island Gate	56	55	54	55
2.	Houghs Neck Sea St.	59	54	52	56
3.	Adams, Shore, Quincy Sea St.	68	64	58	65

(a) A-weighted sound pressure levels, recorded by C.E. Maguire, Inc. during midmorning and afternoon of July 12, 1984.

It is recommended that 39 dBA be used to assess the maximum nighttime noise impact at the property line. Other portions of Winthrop are much farther in distance from Deer Island and thus receive adequate protection with this same criterion. This would also result in a DEQE requirement of 49 dBA for the allowable 10 dBA above ambient stipulated in Massachusetts DEQE Regulation 10 of the Air Pollution Regulations. It is not suggested that a 49-dBA level is the design goal, but rather that this level is a legal requirement that the site must meet as a maximum.

In a similar manner, the criterion for assessing daytime noise impact was determined to be 45 dBA. Since the lowest ambient noise levels occur during the middle of the day and the middle of the night, the maximum impact assessment criteria remain essentially the same during the evening as during the day.

The daytime ambient L90 sound levels taken on Nut Island ranged from 47 to 54 dBA. The quietest of these measurements, the 47 dBA collected in July 1986, has been used as the ambient sound level criterion for assessing daytime construction noise impact at Nut Island. The continuous operation noise is expected to be sufficiently low so as not to cause an impact. The 47-dBA daytime criterion for Nut Island is similar to the 45-dBA criterion developed for Deer Island.

In summary, the ambient sound levels (L90) for assessing maximum nighttime and daytime noise impact in the Point Shirley area are 39 and 45 dBA, respectively. Predicted construction and operation noise are compared with these levels in impact analyses to determine the need for noise mitigation. The DEQE level not to be exceeded for constant nighttime operation noise is 49 dBA at Point Shirley. The criterion for assessing daytime construction noise at Nut Island is 47 dBA.

5.2.5 VISUAL CHARACTER

Deer Island

With an elevation at the summit of 210 ft, the drumlin is the dominant natural feature on Deer Island. Although it has been altered by activities related to the treatment plant and the military, it is still a prominent visual feature, defining and characterizing Deer Island from locations on-shore and in the harbor.

A visual analysis of the island was performed by Jung-Brannen Assoc. in 1986 as part of this study. It identified six visual zones within Boston Harbor -- the inner harbor, Dorchester Bay, Quincy Bay, Hingham Bay, and two clusters of islands: Gallop, Lovells, George's Island, and the Brewsters (Jung/Brannen, 1986). Two major gateways and three minor gateways to the harbor were evident. Deer Island and Long Island frame the major Atlantic gateway to the outer harbor, while Logan International Airport and Castle Island frame the second major gateway between the inner and outer harbor. Nut Island and Peddock's Island create a minor gateway

between Quincy Bay and Hingham Bay. The other two minor gateways do not impact the MWRA project area.

Based on the identification of landmarks, zones of vision were drawn from the near and distant viewpoint landmarks. It was determined that near views to Deer Island were available from various places in Winthrop, Logan Airport, Castle Island, and the islands to the south. Distant views are available from the office towers of downtown Boston and Back Bay, the JFK Library in Dorchester, the shores of Nahant, and the point at Hull High School. From the water, three types of craft have views of the site: commercial ships in the main channels; passenger ferries that follow designated routes; and recreational craft that can view the site from several points.

In addition to the land- and water-based viewpoints, the air vantage point was also considered. With over one million passengers arriving and departing from Logan Airport yearly, the aerial view of Deer Island is an important aesthetic concern.

Nut Island

Nut Island is a peninsula located on the southern shore of Boston Harbor. Existing Nut Island topography is flat, with almost its entire 17-acre area lying between elevations 125 to 130 ft. The edge of this flat area is riprap, which drops off steeply to the intertidal area.

Quincy Great Hill, which is the seaward limit of Hough's Neck, abuts the Nut Island site on its landward side. The hill is a densely developed residential area, with many of the dwellings situated to take advantage of the area's excellent harbor views.

Nut Island is occupied exclusively by structures associated with the primary treatment facility; the tanks are situated at the landward end of the site, while the major above-grade structures are situated at the seaward limit of the site. There is no significant vegetation on Nut Island or on the fill area that connects it to the mainland below Quincy Great Hill. Thus, there is no visual screening of the treatment plant site from Quincy Great Hill.

Nut Island is also visually prominent from vantage points other than Quincy Great Hill, since it is a significant physical feature between Dorchester and Quincy Bays.

There are approximately ten dwellings on the eastern shoreline of Great Hill with near views of the treatment facility. Otherwise, these residents enjoy exceptional views of the harbor, including Long and Peddock's Islands, which appear at this vantage area to be largely undeveloped. The horizon includes the City of Boston skyline on the western end and Point Allerton in Hull on the eastern extreme.

On the shoreline west of Great Hill, approximately 20 houses are located at or near sea level and 8 more have a northwesterly view from 60 to 90 ft above sea level. From the lower elevations, the treatment plant effectively blocks the northeasterly views of the harbor, but

the plant tends to blend in with the general developed character of Great Hill as one continues to look toward the east. The majority of the scenic harbor view from these locations is unaffected by the existing treatment plant. (Metcalf & Eddy, 1982).

Long Island

Long Island is located near the exact geographic center of Boston Harbor. The island is quite removed from residential and commercial areas on the mainland. The nearest residential areas (Squantum and Point Shirley) are three miles away.

Only portions of shoreline communities have a direct view of Long Island. These portions include: Point Shirley, the south-facing neighborhoods of Cottage Hill, Court Park, and Cottage Park in Winthrop; South Boston east of Telegraph Hill; the east-facing slopes of Squantum; the Wollaston Beach community of Quincy; the Hough's Neck area; and the west-facing slopes of Telegraph Hill in Hull. The Long Island Chronic Disease Hospital, situated on a bluff in the central part of the island, is visible from many locations; particularly prominent is the large water tower. (C.E. Maguire, 1984.) Other harbor islands are over one mile from Long Island. George's Island, the most heavily used harbor island, is fully two miles from Long Island.

The dominant topographic and geologic features on Long Island are the drumlins, which stand at an elevation of about 90 ft above the surrounding low land areas. The typical oval shape of the main drumlin, which forms the central part of the island, has been streamlined by wave erosion along the east and west shorelines. Long Island Head, at the northeast end of the island, consists of a drumlin smaller in land area but slightly higher in elevation than the main drumlin. Erosion of this area has been temporarily halted by construction of a seawall on the perimeter. The eroded remnants of two more drumlins are visible at the southeast end of the island in the vicinity of West Head.

The stand of mature pines that brackets the roadway at the southerly end of Long Island presents the viewer with a natural first impression of the visual character of the island. Subsequent views of the abandoned Nike missile site buildings, which have, through vandalism and lack of maintenance, fallen into a state of decay, are only a prelude to the bleak aspect of the Long Island Chronic Disease Hospital. Each of these establishments contributes negatively to the visual quality of the site. (M&E, 1982.)

Long Island Head presents a commanding view of much of the area; the configurations of the island's shorelines are aesthetically pleasing. The man-made features of Long Island Head include a massive granite seawall, a stone paved roadway, the 1819 Long Island Lighthouse, and the remains of the Fort Strong Coastal Artillery gun emplacements and bunkers. Each of these features presents a unique picture that prompts the viewer to inspect them more closely. (M&E, 1982.)

Section 5.2.5 References

Jung Brannen/COM. 1986. Technical Memorandum Harbor Perspective, FD31A, Secondary Treatment Facilities Plan. Massachusetts Water Resources Authority, November 7, 1986, 94 p.

C.E. Maguire, 1984. Supplemental Draft Environmental Impact Statement/Report on Siting of Wastewater Treatment Facilities for Boston Harbor, Vol. 1 U.S. Environmental Protection Agency/The Commonwealth of Massachusetts, 242 p.

Metcalf & Eddy. 1982. Nut Island Wastewater Treatment Plant Facilities Planning Project - Phase I Site Options Study, Vol. II, Commonwealth of Massachusetts Metropolitan District Commission, June 1982, 321 p.

5.2.6 TRAFFIC

Deer Island

Land access to Deer Island is available by only two routes, as shown in Figure 5.2.6-1. The major access route is via Saratoga Street in East Boston. This becomes Main Street in Winthrop at the bridge crossing Belle Isle Inlet. An alternative route is through Revere via Winthrop and Shore Drives. Both roadways are part of Route 145. However, only the Winthrop route is open to trucks along its entire length. Along the designated truck route, there is a 33-ton load limit for the bridge on Saratoga Street.

The traffic capacity of the predominantly two-lane local urban streets in the vicinity of Deer Island is approximately 1,600 vehicles per hour (total for both directions). Currently, traffic flows on local roads are in the range of 150 to 625 vehicles per hour (total for both directions). Traffic volume data for 1984 and 1985 are shown in Table 5.2.6-1. While local roads have more than adequate excess capacity to accommodate additional construction traffic, there is often congestion at certain intersections during the morning and evening rush hours. Calculations performed in the Final Environmental Impact Report, based on U.S. Department of Transportation level-of-service criteria, indicate that long delays can be expected during the evening peak hour traffic at several intersections along the routes to Deer Island, as shown in Table 5.2.6-2 (MWRA 1985).

Nut Island

Access to Nut Island is via Sea Street from Route 3A (the southern artery), as shown in Figure 5.2.6-2. Sea Street is a four-lane roadway connecting Route 3A to Houghs Neck via Adams Shore. All traffic to and from Nut Island must use Sea Street, passing through portions of Quincy before reaching Houghs Neck. From Sea Street, Sea Avenue provides access to Nut Island over Quincy Great Hill. The avenue ascends and descends the hill at a steep grade. Adjacent land is densely developed for residential use. A variety of commercial activities are located

TABLE 5.2.6-1

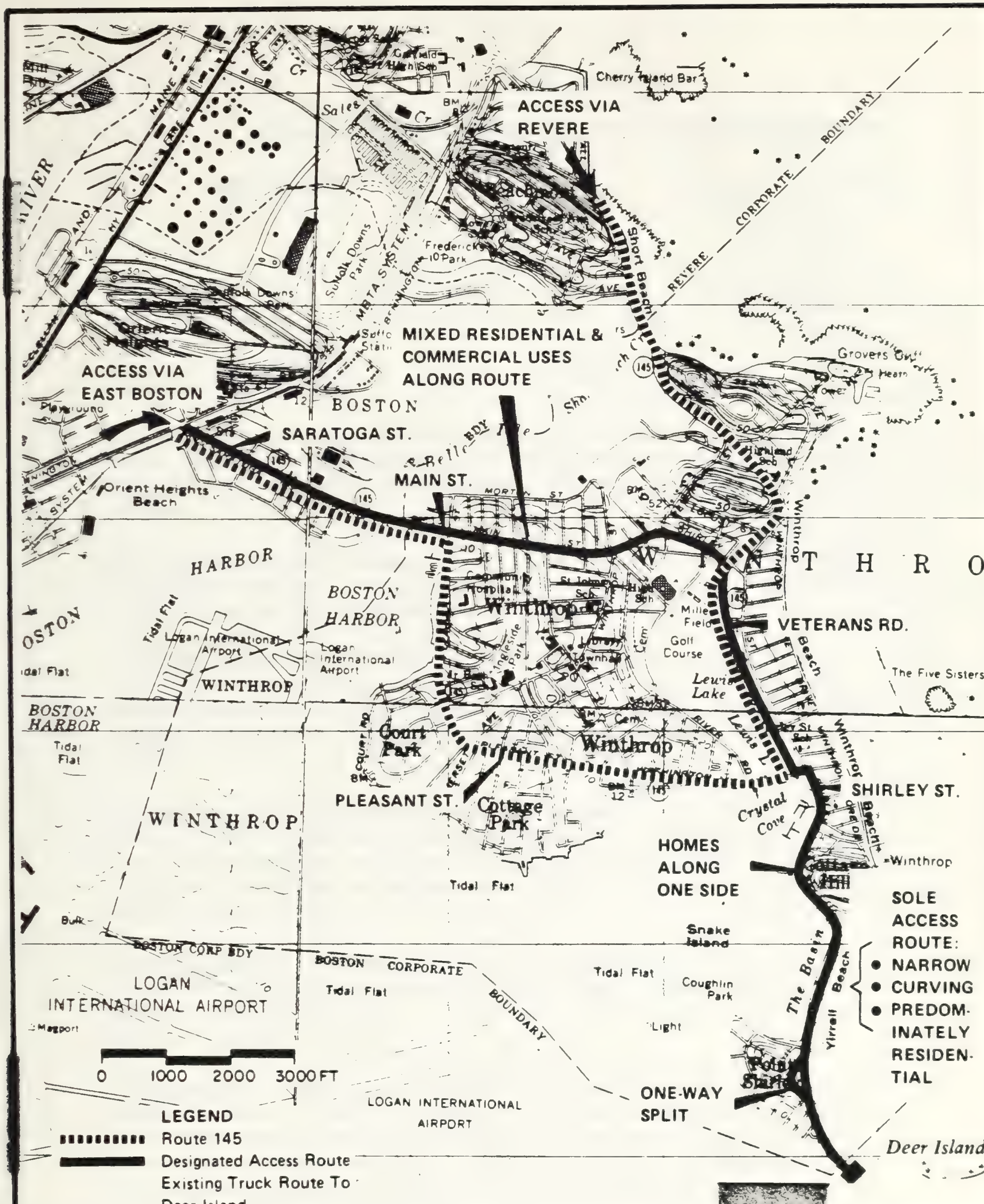
WINTHROP TRAFFIC FLOW DATA, 1984 AND 1985

1984 Data (EPA, 1984)

Location	Two-way ADT	Two-way ADT	Two-way AM peak hr	Two-way PM peak hr
Washington St.	7,700	625		
Veterans Rd.	2,700	225		
Shirley St.				
S. of Washington	6,700	525		
N. of Washington	1,900	150		
Revere and Cross	4,700	370	260	358
Pontos and Petrel	5,300	420	272	343

1985 Data (MWRA, 1985)

	One-way ADT		One-way AM peak		One-way PM peak	
Location	NB/WB	SB/EB	NB/WB	SB/EB	NB/WB	SB/EB
Main St.	6,668	6,349	365	577	614	405
Veterans Rd.	1,194	1,715	81	97	96	146
Shirley St.						
S. of Washington					285	324



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 5.2.6-1
ACCESS ROADWAYS TO DEER ISLAND

TABLE 5.2.6-2

LEVEL-OF-SERVICE CRITERIA FOR SIGNALIZED INTERSECTIONS

Level of service*	Stopped delay per vehicle (sec)
A	$\leq$ 5.0
B	5.1 to 15.0
C	15.1 to 25.0
D	25.1 to 40.0
E	40.1 to 60.0
F	> 60.0

*Definitions of Levels of Service:

Level-of-service A describes operations with very low delay, that is, less than 5.0 sec per vehicle. This occurs when progression is extremely favorable, and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.

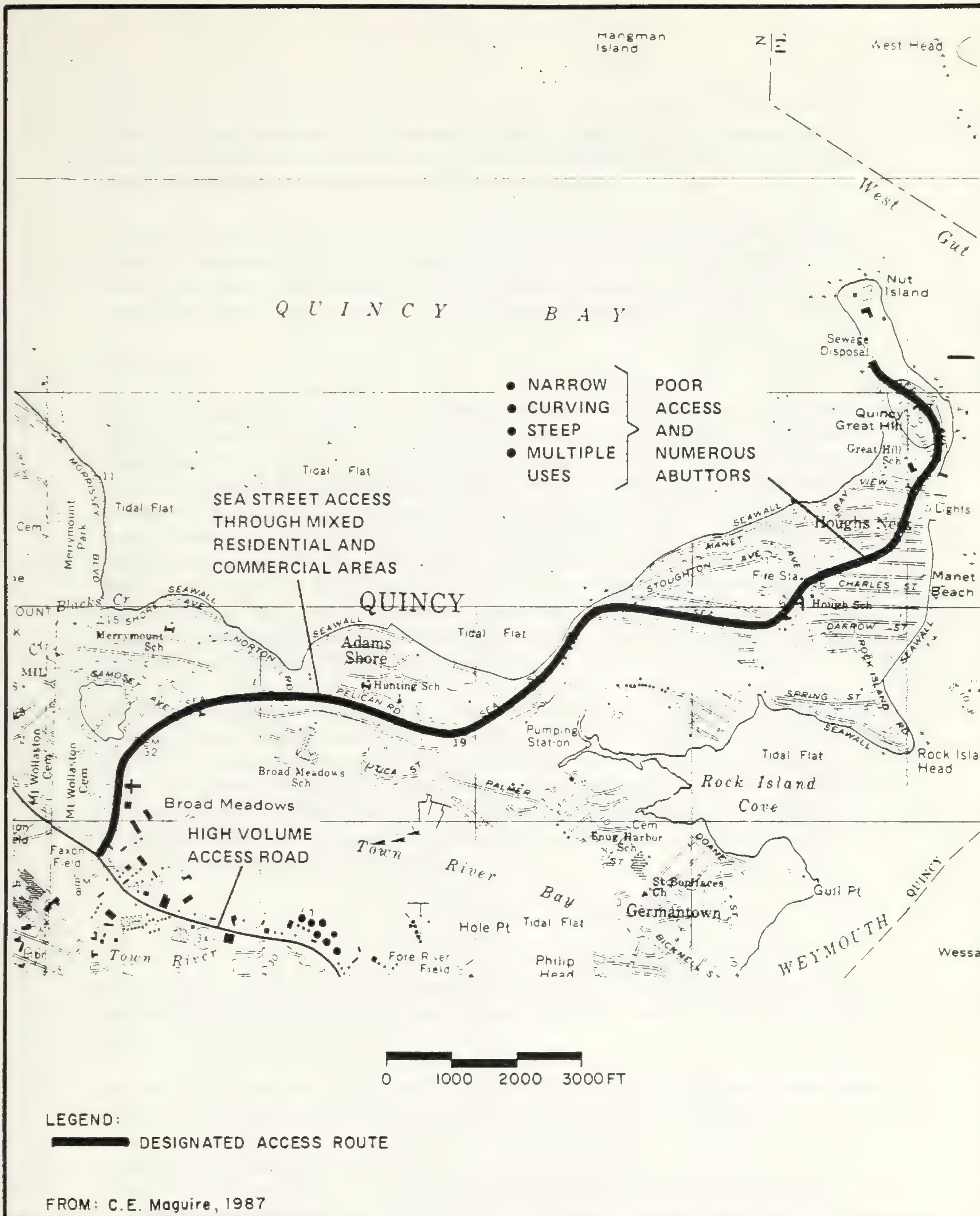
Level-of-service B describes operations with delay in the range of 5.1 to 15.0 sec per vehicle. This generally occurs with good progress and/or short cycle lengths. More vehicles stop than for length-of-service A, causing higher levels of average delay.

Level-of-service C describes operations with delay in the range of 15.1 to 25.0 sec per vehicle. These higher delays may result from fair progression and/or longer cycle lengths. Individual cycle failures may begin to appear in this level. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping.

Level-of-service D describes operations with delay in the range of 25.1 to 40.0 sec per vehicle. At level D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, and high v/c ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

Level-of-service E describes operations with delay in the range of 40.1 to 60.0 sec per vehicle. This is considered to be the limit of acceptable delay. These high delay values generally indicate poor progression, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent occurrences.

Level-of-service F describes operations with delay in excess of 60.0 sec per vehicle. This is considered to be unacceptable to most drives. This condition often occurs with oversaturation, that is, when arrival flow rates exceed the capacity of the intersection. It may also occur at high v/c ratios below 1.00 with many individual cycle failures. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.



MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 5.2.6-2 ACCESS ROADWAYS TO NUT ISLAND

nearby, with cars parking on the street. The two-lane, two-way portion of Sea Street has a capacity of 1,600 vehicles for both directions of travel (Table 5.2.6-3). The existing traffic through this section of the access route is estimated at only 600 vehicles per hour, indicating more than sufficient capacity on Sea Street for additional traffic.

Because of the particularly narrow and winding local streets in Hough's Neck and on Quincy Great Hill, plant operations have also involved disruption of traffic along the adjacent roads leading to the plant. Safety concerns have been raised by residents over deliveries of chlorine gas by truck and potential for leaks of chlorine on the site (C.E. Maguire, 1987).

Long Island

Access to Long Island by automobile is limited to one route, which includes Squantum and Dorchester Streets along the western shoreline of Squantum, the Long Island Viaduct, and the Long Island Bridge. All of these roadways are two lanes in width, are in reasonably good condition, and do not have steep grades or abrupt changes in direction. The only truck access to Squantum is via the Southeast Expressway and Morrissey Boulevard via the Hancock Street Bridge. Direct access from Quincy, to the south, is not convenient for truck traffic since such vehicles are prohibited from using Quincy Shore Drive and the Furnace Brook Parkway (M&E, 1982). Vehicular access to the Long Island viaduct is physically and administratively controlled by the City of Boston Department of Health and Hospitals police. As a result, the volume of traffic using the viaduct is limited to that connected with hospital business or associated with the Boston Police and Fire Department installations on Moon Island.

The Long Island Bridge was constructed by the U.S. Army Corps of Engineers and opened in 1951. It is a steel plate girder structure with a clear center span of 150 ft and is the only means of vehicular access to Long Island. The size (25-ton limit) and number of trucks that use the bridge are restricted by the City of Boston Department of Public Facilities; thus, the bridge is the limiting factor to Long Island access. A complete structural evaluation of the bridge is required before it can be included as a part of any plan for construction of facilities on Long Island requiring significant truck access.

Section 5.2.6 References

C.E. Maguire. 1987. Final Environmental Impact Report - On-Island Water Transportation Facilities for Deer Island and Nut Island. Massachusetts Water Resources Authority, March, 1987.

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Metcalf & Eddy. 1982. Nut Island Wastewater Treatment Plant Facilities Planning Project - Phase I Site Options Study, Vol. II. Commonwealth of Massachusetts Metropolitan District Commission, June, 1982, 321 p.

TABLE 5.2.6-3

TRAFFIC FLOW IN THE VICINITY OF NUT ISLAND

Location	Lanes	ADT	Two-way* DHV	One-way DHV	One-way capacity*
Quincy Shore Drive	4	24,150	1,950	1,365	2,800
Seat St., west of Quincy Shore Drive	4	34,300	2,750	1,925	2,800
Sea St., east of Quincy Shore Drive	4	20,400	1,650	1,115	2,800
Sea St., east of Rockland St. Winthrop St.	2	7,350	600	**	1,600***
Southern Artery south at Sea St.	4	32,700	2,600	1,820	2,800
Sea St. at Southern Artery	4+	36,850	2,950	2,065	2,800

* Source: Highway Capacity Manual, 1965.
** Use two-way DHV figure for comparison.
***Two-way capacity.

Data from EPA 1984.

5.2.7 HISTORICAL AND ARCHAEOLOGICAL RESOURCES

Deer Island

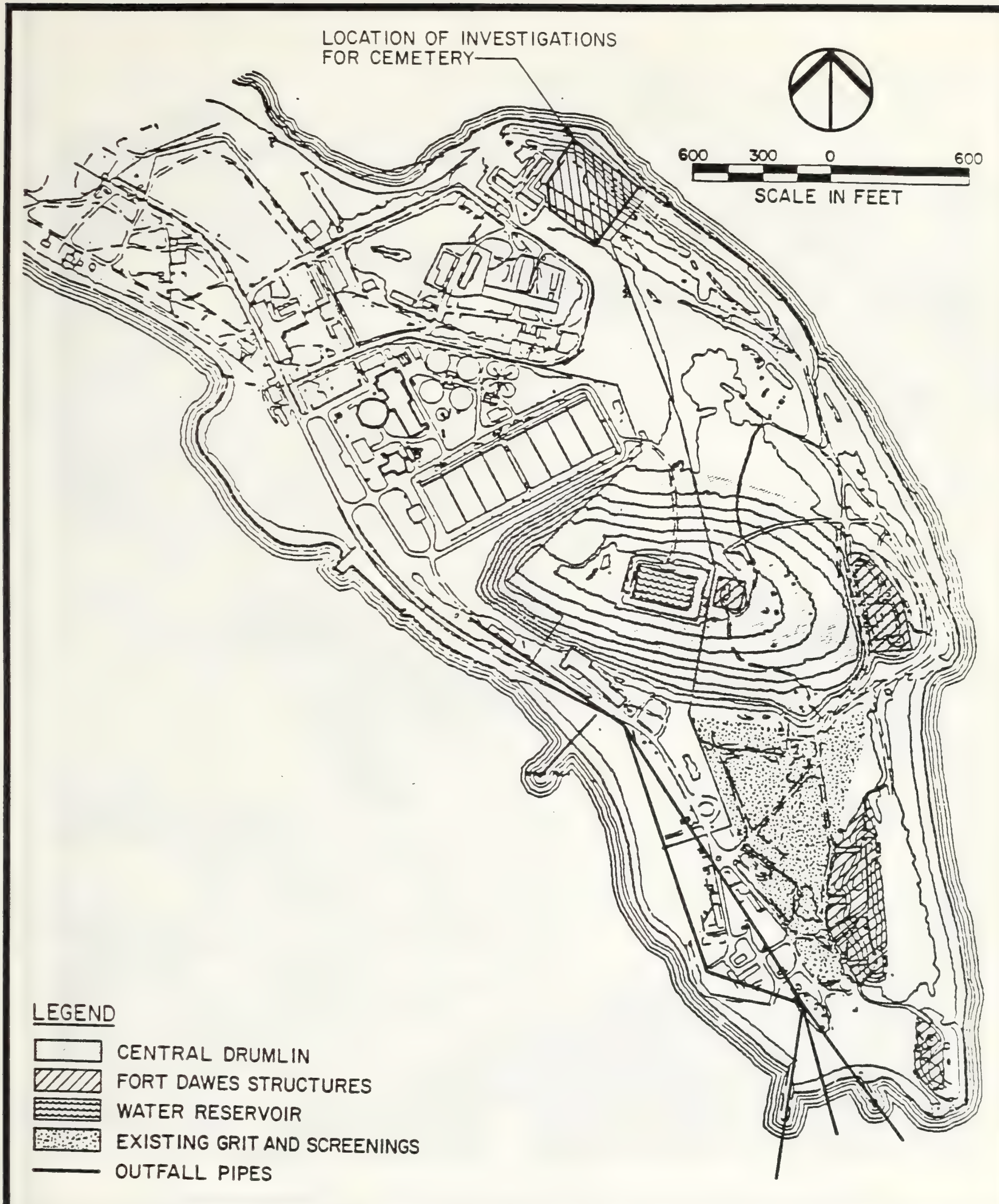
Deer Island's historical and archaeological resources date from the 1840s to about 1930. They consist of a cemetery and mausoleum, the Deer Island House of Correction, and the Deer Island Pumping Station. Public Archaeology Laboratory, Inc. (PAL) conducted the archaeological surveys from 1985 to 1987, and Boston Affiliates, Inc. performed the historical survey in the same period.

Cemetery and Mausoleum. As part of the siting process for this project, a reconnaissance-level archaeological survey was conducted by PAL in September 1985 to identify and document cultural and archaeological resources as well as to assess the extent of previous disturbance within the designated project area.

In the course of the archaeological reconnaissance survey, a historic-period cemetery and mausoleum were identified on Deer Island (Figure 5.2.7-1). The cemetery plot and associated vault are located on a slope on the northeast side of the island between the old piggery and the concrete boundary wall that originally separated the City of Boston property from the U.S. military reservation on the southern half of Deer Island. It is referred to hereafter as the northeast, or new, cemetery.

A more intensive archaeological survey was carried out in 1987 by PAL to assess the significance of the historic-period cemetery. The survey was planned in two basic stages: documentary research, to be followed by site verification.

The specific objectives established for the documentary research were: (1) to establish the period of active use of the cemetery identified during the reconnaissance survey; (2) to establish if this cemetery is older than the 1908 mausoleum associated with it; (3) to determine, if possible, whether the known cemetery contains any burials that were removed from earlier nineteenth-century plots formerly located on other sections of Deer Island; (4) to determine if the cemetery plot near the 1908 mausoleum could contain older (nineteenth century?) reinterred burials; (5) to consult records maintained by the military (Army Corps of Engineers) for any information relevant to the final disposal of burials from Resthaven Cemetery on the southern tip of Deer Island; (6) to determine when Resthaven Cemetery was first actively used by the correctional facilities; and finally, (7) to locate documentary sources describing the methods used in the burial of almshouse or prison inmates on Deer Island (individual graves, large trenches, etc.). What this research revealed is that the northeast cemetery plot is much larger than was expected based on the cursory field inspection of the site. Judging by the 1929 photo shown in Figure 5.2.7-2, the cemetery extended from the northeast wall of the old piggery to the cement boundary and from the sea wall at the top of the slope to the mausoleum at the foot of the slope. The many wood scraps originally thought to be picket fence remains and, therefore, assumed to be markers of the plots' boundary, were more likely remnants of the wooden crosses that once marked the graves in the tightly packed cemetery. A summary of the documentary research is provided in Appendix D of this volume.



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 5.2.7-1
LOCATION OF CEMETERY INVESTIGATIONS

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 5.2.7-2

1929 DEER ISLAND PHOTOGRAPH SHOWING NEW RESTHAVEN CEMETERY UPPER CENTER

Since no evidence has been found suggesting the removal of these burials to another location, it is expected that some 4,160 to 4,500 bodies remain interred in the new cemetery. The only evidence for the plan of burials within the new cemetery is the 1929 photo. It suggests that either individual graves were located very close together or that individual crosses marked bodies buried in trenches. The latter possibility seems most probable for the reinterments due to the age and likely condition of the earlier burials when transferred from the old Resthaven Cemetery, where evidence indicates the bodies were buried eight to ten per trench.

Additional archaeological testing was undertaken in May 1987. The results will be included in the final report. Two methods of remote sensing techniques, soil resistivity and electron magnetometry, have been used to attempt to discern any patterns of disturbance that may be present in the area of the historic-period cemetery and could possible signify burials. Experience with soil resistivity testing at several historic-period cemeteries ranging in age from the late seventeenth to nineteenth centuries has indicated that more recent burials have greater resistivity. A soil resistivity survey of the Deer Island cemetery has been used to identify the probable location of burials prior to any actual subsurface testing. Electron magnetometry works in a similar manner and has been used as a second verification method. The results of the soil resistivity and electron magnetometry surveys have been used to develop a map or plan of the location of soil anomalies. This map was subsequently used in consultation with the Massachusetts Historical Commission, to plan an effective subsurface testing or burial verification program for the cemetery.

The primary objectives or tasks for the recommended fieldwork have included: (1) determination of the horizontal extent of the cemetery through systematic subsurface testing and (2) collection of sufficient data to reconstruct the internal configuration or plan of the cemetery and general mode of burial (individual graves, multiple burials in trench, etc.) used at this site.

Actual subsurface testing within the known cemetery is being performed to verify the existence of burials. This fieldwork involves the use of both machine-assisted and hand-excavation techniques. A small backhoe or similar machine will be used to excavate a series of narrow trenches through the cemetery to expose the upper surface of filled grave shafts. Machine-excavated trenches could be oriented in several ways within the cemetery area. Subsurface anomalies located by soil resistivity testing that represent potential unmarked burials could be tested with judgementally oriented trenches placed on the locations of these anomalies. Other deliberately placed trenches will be necessary to identify the horizontal limits of the cemetery if it is found to actually contain unmarked burials. Given the moderately sloping surface of the cemetery, the machine-excavated trenches will probably have to be oriented perpendicular to the natural slope, since it would be unlikely that a backhoe or similar equipment could operate across this slope. These trenches will be excavated with machinery (small backhoe or front-end loader) only to a depth sufficient to identify a filled grave/burial shaft. Once a definitive grave shaft or fill has been identified, hand excavation will be used to complete the investigation. Excavation with hand tools would proceed only until the presence of human skeletal remains can be verified within an identified grave or burial. Once human skeletal remains have been positively identified, they will be left _in situ_ and the state archaeologist will be notified.

Representative soil profiles will be recorded from all machine-excavated trenches and scaled drawings will be made of profiles exposed during the excavation of specific burials. Locations of trenches excavated during the archaeological investigation and any burials identified during the survey will also be mapped. All aspects of the archaeological investigation will be recorded in documentary photographs (color and black/white). This would include photographing any burials located and positively identified during fieldwork. The final report summarizing the results of the archaeological testing will be included in the Treatment Plant EIR/EID, Volume III.

Deer Island House of Correction. Owned by the City of Boston since 1634, Deer Island in Boston Harbor has proven a useful place for purposes that needed a site but had to be set apart from a populated area. Its use has included the detention of Indians and the quarantine of contagious immigrants.

In 1850 the City sited a municipal almshouse there, which became the first in a complex of institutions serving the poor, the criminal, and the delinquent. The almshouse was known as the House of Industry; other buildings, such as a reformatory and schools for pauper boys and girls, were added in the next three decades. In the 1890s, the whole complex started being used for the detention of prisoners and was called the House of Correction, the name still used today.

The Deer Island group of institutions for many years was self-sufficient, providing its own food from animals and farming. Dairy barns were built as late as the 1950s, but farming has since ceased. The island was accessible by boat, and the Penal Institutions Department maintained its own steamboat to transport inmates between islands and the mainland. In 1940 the island was connected by causeway to Point Shirley in Winthrop.

Deer Island previously has not been surveyed for historical significance. Consequently, none of the buildings is listed in official inventories or has been identified as eligible. The main points of historic interest are the following:

o Administration Building (ca. 1850, 1929, 1949)

This building incorporates major sections of the Deer Island Almshouse (also known as the House of Industry), designed by Gridly J. F. Bryant (1816-1899) with the assistance of Louis Dwight of the Prison Discipline Society. The original building was of brick, in Italianate and vernacular style.

Fire damage in 1929 and 1949 led to the removal of the roof and portions of the building. Modern sections were added at the back.

Interior hallways and offices on the first floor have woodwork, matchboard panelling, and cast-iron columns that are apparently original. The cellblock appears to date from the late nineteenth century and is probably the addition designed by city architect Edmund Wheelwright in 1892.

The building is now used as administrative offices, reception, and cells for new prisoners, training and schoolrooms, and workshops. The building appears structurally sound but worn and neglected.

- Hill Prison (1902-04)

This building appears to be substantially unaltered. It was built as a women's prison but is now the main prison in the complex, occupied solely by men.

The architect was A. Warren Gould, active in the 1890s in Boston, where he designed a number of houses and buildings in Dorchester, including Whiton Hall for the Dorchester Women's Club. He moved to the Pacific Northwest and died in Seattle in 1922.

The building is T-shaped. The two side wings contain cellblocks, while the rear wing contains dining and recreational facilities.

The building is of loadbearing brick, 24 in thick at first-floor level; the foundations and entrance facade are granite. The floor construction is reinforced concrete, and brick vaults span the cell-block open areas. Interior supports are cast-iron columns and masonry. The pitched roofs are covered with slate.

The style of the building is classical revival. The central section has a granite facade in the lower half, brick in the upper half. In the granite section, two projecting bays flank an arched entrance in Palladian style, above which is a recessed balcony set in a semicircular arch. Above are a series of vertical brick pilasters between windows, topped by an entablature and surmounted by a hipped roof with clipped dormers and a prominent cupola.

The two wings contain a series of wide brick pilasters alternating with narrower barred windows arched at their tops. Since these windows give onto the open space of the cellblocks, there are no floors behind them, and the windows are virtually continuous strips. Above is a broad entablature. The roof is pitched and has ventilators at the ridge, which were once open roof viewing platforms. The end walls of the wings have the same pilaster and arched window motif of the front and rear elevations; the windows are bricked up.

The rear wing, also roofed with a pitched slate roof, has a series of brick semicircular arches, with windows at each floor level. In the uppermost floor -- the recreation hall -- the upper section of the window is blocked with plywood. The end wall of this wing is the stage wall and is solid brickwork. The outer skin of this wall collapsed recently and has been replaced.

Inside the building, most of the spaces are utilitarian. There is some architectural interest in the front entrance hall and in the recreation hall, which still retains original woodwork in the doorways, stage and proscenium arch, and balcony.

The building appears to be structurally sound. Inside all surfaces show signs of much wear, poor maintenance, makeshift repairs, and careless painting.

o Superintendent's Office (1930)

This red brick building, situated on the waterfront opposite the administration building, originally housed doctors and other professional staff of the Deer Island House of Correction.

The building, which resembles a traditional single-family home, is Georgian revival in style. It is composed of a rectangular 2-1/2 storey block with a high-pitched slate roof and a flat-roofed single storey service wing to the side. It is faced with Flemish bond red brick and has a cast-stone foundation and details.

The main facade has three bays of windows on either side of a central entranceway consisting of a pair of Corinthian columns and a segmental arch. The front slope of the roof has five gabled dormers; the rear of the structure has four dormers and four pairs of French doors leading onto a cast-stone terrace.

The superintendent's office was initially believed to date from circa 1910, based on visual analysis. Subsequent research, however, has indicated that it was constructed in 1930 to replace the original doctor's wing destroyed in the fire in the administration building in 1929. The structure was designed by the M.A. Dyer Company, a Boston architecture and engineering firm.

Subsequent to its use as the doctors' house, the structure became the penal commissioner's residence. Beginning in 1973, it housed inmates participating in the work-release program. In 1985, the building was renovated for use as office space. This renovation resulted in considerable alteration to the interior and the replacement of the original windows with vinyl copies.

o Ancillary Buildings

a. Garage - twentieth century.
b. Commissary - twentieth century. This building was previously three and a half stories, but was reduced to a one-storey building in 1946.
c. Dormitories (former dairy barns) - 1957 and 1958. Architect, Joseph F. Page
d. Shower block - probably the former poultry house, 1957. Architect, Joseph F. Page.
e. Chapel - 1950s.
f. Power Plant - 1958. Engineers, J. M. McKusker Associates.
g. Dormitory and laundry (opposite Hill Prison) - This building may be a remnant of the nineteenth-century pauper girls' school.
h. K-9 quarters - 1980s. On the site of the former piggery.
i. Work-release house - 1920s (?).
j. Sheet metal shop - twentieth century.

o Site Plan (ca. 1850 to present)

The Deer Island House of Correction consists of a grouping of major and ancillary buildings informally sited in an institutional setting.

The buildings form two clusters. Near the water's edge, the predominant building is the administration building, sited parallel to the main road that traverses the island. Opposite the administration building is the superintendent's office; nearby is the work-release house. Behind the administration building and parallel to it are a garage and a commissary.

Up on the hill, the predominant structure is the Hill Prison, sited on a street sometimes referred to as Hill Prison Street. Across from the Hill Prison is the dormitory and laundry building. Next to the Hill Prison are two dormitories, a chapel, a shower room, and the powerhouse. Below and across a road is the sheet metal shop. Behind the Hill Prison are the K-9 quarters.

The buildings are informally set on the site, which has a character that is institutional, industrial, and rural. A loop road gives vehicular access to all buildings. It is paved, but without curbs in most places. The largest expanse of paved area is between the administration building and the garage and commissary. Stone retaining walls and foundation walls of demolished buildings occur on the site. Cyclone fencing and wooden telephone poles are in evidence. Trees, bushes, and an overgrowth of grass contribute to the rural character of the site.

Significance. The Massachusetts Historical Commission reviewed the historical and architectural survey in December 1985 and made the following finding about the historical significance of the Deer Island House of Correction (see Appendix C):

> We...found that the Deer Island prison complex does not meet National Register of Historic Places Criteria, but that several components individually meet NR criteria.
>
> While individual components of the Prison Complex do retain integrity to their period of significance, the complex as a whole does not, having been altered through the construction of numerous small utility buildings in the 1940s, 1950s, and 1960s and through the demolition or substantial alteration of original elements and significant later structures, such as the ca. 1850 House of Industry and the Pauper Boys' School.
>
> Components considered to retain integrity to their period of significance and to meet National Register criteria A and C on the local level are the following:
>
> Hill Prison (1902-04) - Classical Revival building retaining significant elements of its design; significant for its associations with the development of institutional controls in the City of Boston; as an illustration of the continued usage of the Harbor Islands as the historic location of undesirable social institutions (Boston's institutional fringe) and architecturally as a good example of turn-of-the-century institutional design and practice, reflecting current philosophies regarding criminal justice and social reform.
>
> The Superintendent's Office (ca. 1910) is an excellent example of Georgian Revival architecture in a good state of preservation. Historically, the office reflects the importance and high status of the Superintendent in its prominent siting and imposing design.

Deer Island Pumping Station. In 1889, legislation, prompted by reports of the Massachusetts State Board of Health on pollution of Boston Harbor, authorized the formation of the Boston Metropolitan Sewerage Commission. By 1900, the North Metropolitan Sewerage System, serving the 14 cities and towns of the commission's northern region, was fully operational.

The North Metropolitan System's 74 miles of sewer lines connected nearly 1,000 miles of local lines and pumped to an outlet in the Boston Harbor at Deer Island. The pumping station at Deer Island was the largest of three stations constructed to pump wastewater through the North Metropolitan System. Constructed in phases in the period from 1894 to 1900, the Deer Island Pumping Station's development reflected the growing needs of the region's burgeoning population.

The pumping station at Deer Island lies on the southwestern side of the island about midway down its length. Actually a complex of five attached buildings, the development of the station reflects the development of the North Metropolitan Sewerage System. Completed in three phases between 1894 and 1899, the complex contains a screen house, a coal house, a boiler room, and two engine rooms. The buildings give the appearance of a single structure, designed in a compatible manner by Arthur F. Gray, architect for the stations at Charlestown and East Boston. Though operated in the periods between construction, it became fully operational in May of 1900. The station was in operation until 1968, when the Deer Island Wastewater Treatment Plant was completed. The building, still containing the old machinery, is now abandoned. To the southeast of the pumping station complex is a two-storey shingle structure referred to as the "farmhouse."

Facing the westerly elevation, the pumping station buildings are, from left to right:

o Screen House (ca. 1895)

A two-storey brick, granite and terra cotta structure 27 ft by 23 ft. Built in a simple vernacular industrial style with Queene Anne-Romanesque elaborations and detailing, it has a hipped roof of slate with terra cotta tile coping and is surmounted by a cupola, now only partially extant.

o Coal Pocket (ca. 1895)

A one-storey brick, granite, and terra cotta building, 74 ft by 34 ft with a dynamo room attached. Styled similarly to the screen house, it also has a slate pitched roof punctuated by dormer-type openings and terra cotta tile coping.

The engines for the pumping station were powered by coal burned in the boiler room until the facility was converted to diesel fuel in the 1950s. The coal pocket was designed to hold 600 tons of coal.

o Boiler Room and Chimney (Sept. 1894)

A one-storey brick, granite, and terra cotta structure, 63 ft by 35 ft with a height of 17 ft

to the roof trusses and an accompanying masonry chimney 125 ft in height. The structure is styled in a vernacular Romanesque with Queen Anne details, slated pitched roof with terra cotta tile coping, and topped with a ventilation structure. Converted from coal to diesel in the 1950s, the boilers are still intact. The boiler room and the first engine room were the initial structures built for the pumping station, which shares its pattern of boiler room-engine room with the stations at East Boston and Charlestown.

- Engine Room (second) (ca. 1899)

A two-storey brick structure approximately 50 ft by 50 ft with a hipped slate roof. The structure is built in a more formal style with Romanesque details of round-headed arches, brick patterns to create circles, and horizontal lines denoting function.

Because of a need for increased system capacity, an extra pump and engine were added to the Deer Island pumping station and housed in this structure. The machinery is still extant.

- Farmhouse (ca. 1900)

Approximately 300 ft to the southeast of the pumping station stands a two-storey wood and shingle Queen Anne/Colonial Revival structure that is known as the "farmhouse." Physical evidence indicates that the original structure, a simple rectangular two-storey barn, received later additions, probably around the turn of the century. The original barn forms the north wing, while the later construction consists of the central stable-like area and the attached south wing. The south wing apparently was designed and used as a residence for employees of the pumping station and possibly the superintendent. Employees of the pumping station at various times used the north and central wings as a locker building, a tool room, a stable, and a garage. The MDC at one time used the farmhouse as a storage area for old documents and tires. It is now in a dilapidated condition.

Significance. The Massachusetts Historical Commission, in its review of the historical and architectural survey of Deer Island, concluded the following about the pumping station (see Appendix B):

> ...we find that the Deer Island Pumping Station Complex appears to meet National Register Criteria A and C.
>
> The Pumping Station meets criteria A and C,
>
> 1) as a substantially intact sewage pumping complex illustrating the development of the Metropolitan District Commission, one of the earliest major environmental management agencies in the country, and of the City of Boston and its surrounding area, which experienced substantial growth at the turn of the century, and
>
> 2) as an architecturally distinguished pair of buildings in the Romanesque Revival and Queen Anne styles. The pumping station, built between 1849-99, is notable for its high quality design and materials while the adjoining farmhouse is a particularly

good example of Queen Anne/Shingle Style architecture.

Long Island

Shortly after the founding of the Massachusetts Bay Company, Long Island was cleared and leased to about 40 tenant farmers. The existing lighthouse on Long Island Head drumlin was constructed in 1819 and is an example of Federal period design. In 1850, plans were prepared to subdivide the island for a residential community. The lots, however, were not sold and the plan failed. At about the same time and for 37 years following, a colony of fishermen lived on the island. Before the outbreak of the Civil War, a battery of guns was constructed on Long Island Head drumlin. During the Civil War, a conscript camp was set up on Long Island. Closer to the southern end of the island is a memorial to 79 Civil War Dead, who were reinterred in the island's cemetery. The camp, renamed Fort Strong in 1867, was extensively renovated in 1899, when several batteries of six- and twelve-inch guns were built. During World War I, 1,500 men were quartered in the fort. Fort Strong was declared surplus in 1946. The City of Boston destroyed some of the old military structures in 1968, the rubble of which still litters part of the head.

Long Island Hospital began as a hotel, which was built when the island was a popular resort. Ten years after it was built, in 1882, the City of Boston purchased the hotel to house the poor, paupers, unwed mothers, and, later, homeless men. Today, the hospital consists of about 20 buildings providing care for the homeless, the elderly, and the "chronically" ill (C.E. Maguire 1984).

The National Register of Historic Places does not identify any sites of historic or archaeological significance on Long Island, although the island system is being nominated as a district prominent for prehistoric archaeological resources (M&E 1982). The Massachusetts Historical Commission has identified and described two archaeological sites on this island.

Historic records mention that the first of these two sites was used as a wintering ground by Natick Indians between 1662 and 1675.

The second site is a midden, a refuse pile, composed mainly of Mya with some Mytilis, stone flakes, and artifact fragments. It is estimated that the site was probably occupied during prehistoric times. The site was excavated in 1971, and the artifacts found are now in the Peabody Museum.

Long Island Head, at the northern end of the island, is the site of Fort Strong, as well as the twice moved 1819 Long Island Lighthouse. While the barracks and other facilities once in existence at Fort Strong have been razed, coastal defense gun emplacements of two distinct eras remain. An antebellum three-gun battery constructed of granite, with a connecting tunnel, is situated on the seaward slope in front of the Endicott-period fortifications of reinforced concrete that occupy the highest point of Long Island Head. This concrete fortress was built to house five large-caliber rifles on disappearing carriages and was an important part of the Boston Harbor defense system during the period immediately following the turn of the nineteenth

century. Fort Strong has fallen into decay since it was declared surplus by the government in 1946 (M&E 1982). This site, which has historic interest, is not currently recognized as an historic site by any agency empowered to classify and preserve or protect such resources.

The cemetery and monument to 79 Civil War Dead, located south of the hospital on the east side of the access road, also has historic interest. As is the case with Fort Strong, these features are not listed in the National Register of Historic Places nor are they recognized by the Massachusetts Historical Commission.

Nut Island

Nut Island in Quincy was once a 4-acre island located just north of Quincy Great Hill on Hough's Neck. In 1893, the MDC built a road to the island and enlarged it to accommodate a pumping and screening station and outfall. In 1949, the island was again enlarged. The existing primary treatment plant and associated facilities occupy the entire 17-acre area of the island.

The National Register of Historic Places and the Massachusetts Historical Commission do not identify any sites or features of archaeological or historic significance on Nut Island; it is likely that no such sites exist because the island has been significantly altered to support the wastewater treatment facility.

Section 5.2.7 References

(References used to document the archaeological features of Deer Island are listed in Appendix D, Archaeological Documentary Research Undertaken by Public Archaeology Laboratory, Inc.)

C.E. Maguire. 1984. Supplemental Draft Environmental Impact Statement/Report on Siting of Wastewater Treatment Facilities for Boston Harbor, Vol. 1. U.S. Environmental Protection Agency/The Commonwealth of Massachusetts, 242 p.

Metcalf & Eddy. 1982. Nut Island Wastewater Treatment Plant Facilities Planning Project - Phase I, Site Options Study, Vol. II. Commonwealth of Massachusetts Metropolitan District Commission, June 1982, 321 p.

Section 6

6.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

6.1 SYSTEM REQUIREMENTS

The MWRA wastewater collection and treatment system consists of a North System and a South System. Currently, the North System wastewater is treated on Deer Island, and the South System wastewater is treated on Nut Island. The new Deer Island treatment plant will treat wastewater from both the North and South Systems. After consolidation of wastewater treatment facilities at Deer Island, only preliminary treatment, consisting of screening and grit removal, will be provided for the South System flows at a new headworks on Nut Island.

The inter-island transport system will convey wastewater from Nut Island to new treatment facilities on Deer Island, a distance of approximately 5 miles.

In addition to a conduit, a pumping station will be required because the hydraulic gradeline of the wastewater arriving at Nut Island is at a lower elevation than the gradeline elevation required at the new Deer Island wastewater treatment plant. This pumping station will be called the South System Pumping Station. In summary, the two basic components of the system will include an inter-island conduit and a pumping station. Alternatives for the conduit and the pumping station are discussed separately.

6.2 CONDUIT

6.2.1 SCREENING EVALUATION

Method of Construction

The conduit could conceivably be constructed by any of three methods: marine pipeline, sunken tube, or deep rock tunnel.

A pipeline would be built by conventional marine construction methods. In deep water, barge-mounted equipment would be used to excavate a trench by clamshell, place a layer of stone bedding in the trench, lower and install sections of pipe in lengths of approximately 16 ft, and place backfill and stone cover protection as required. In shallow near-shore areas (surf zone), a stationary trestle supporting a traveling crane on rails would be constructed to perform the same duties as the barges.

The sunken tube method of construction has been successfully used on a number of underwater vehicular tunnels, particularly in the Chesapeake Bay area. This type of construction is considered potentially cost effective for diameters over 12 ft, which is only slightly larger than that anticipated for the inter-island conduit. The tube would be fabricated from steel in lengths of approximately 200 ft. The tube would be outfitted with interior and exterior concrete, towed into position over an excavated trench, and sunk into the trench. Trench excavation, stone bedding, backfill, and cover protection procedures would be similar to those required in pipeline construction.

The major difference between the pipeline and the sunken tube alternatives is the length of sections lowered into the trench: approximately 16 ft for the pipe and 200 ft for the tube.

The deep rock tunnel alternative is a conventional method of construction that has been used successfully in the Boston area and throughout the world. Vertical access shafts would be constructed on land at the beginning and the end of the tunnel. These shafts would penetrate through the overburden and onto sound rock and terminate approximately 200 to 300 ft below the surface. The tunnel would be excavated by a tunnel boring machine (TBM) or drill and blast techniques, and then the tunnel would be lined with concrete.

Although three methods of construction are considered, there are limitations on the use of a marine pipeline or a sunken tube for the inter-island transport system. The inter-island conduit must cross the main Boston shipping channel along the route from Nut Island to Deer Island. The crossing will be in President Roads. A large-diameter pipeline (or sunken tube) traversing the shipping channel is not practical for the following reasons:

1. The water depths in the channel are 60 ft to 70 ft below mean low water. Due to burial and cover protection requirements, the bottom of a pipeline trench would be approximately 80 ft to 90 ft below mean low water. Since the pipeline must slope continuously downward toward Deer Island to prevent solids deposition, a pipeline trench across Deer Island would be well over 100 ft deep, which would place the lower 15 ft to 25 ft of the excavation into rock. The length of this trench on Deer Island would be over 2,000 ft long. The depth of cut, length of trench, and required rock excavation make this alternative undesirable.

2. All ship traffic to and from Boston passes through President Roads. A major pipeline construction across this busy narrow shipping lane would require careful coordination with the U.S. Coast Guard to avoid unsafe conditions during construction. Although this type of construction is possible, it is not desirable if alternative means are available.

3. Although there currently are no plans to do so, it is conceivable that the shipping channel may be deepended during the project life or beyond. If this occurs, another conduit would have to beconstructed.

For these reasons, the deep rock tunnel is the only method of construction considered for traversing the Boston shipping channel. It would be possible, however, to construct a pipeline or sunken tube between Nut Island and Long Island and to complete the inter-island conduit by constructing a deep rock tunnel between Long Island and Deer Island.

Number of Conduits

The inter-island conduit is a passive element of the system. It is a structure with no moving parts and thus not subject to mechanical breakdown. However, the conduit must be protected from damage or failure which could result from earthquake, bottom slides, anchors, erosion, wave forces, and settlement. Because these types of problems could damage or fail a single- or

a double-conduit system equally, a single-conduit system, which is far less costly than a double-conduit arrangement, will be selected. A single-conduit system will be able to handle the range of wastewater flows.

If the conduit is a deep rock tunnel, it would be, by its nature, suitably protected. If the conduit is a pipeline or a sunken tube, protection would have to be provided. A pipeline would be buried sufficiently deep that the top of an armor stone protective cover would be level with or deeper than the existing sea bottom. The pipeline would be covered with a minimum of 6 ft of armor stone. Within the surf zone, the armor stone cover would be 10 ft.

Materials

The project planning period is 25 years, from 1995 to 2020. It it should be anticipated, however, that the conduit may be required to function well beyond 2020. Its life expectancy is 50 years. The MWRA has had good experience with concrete pipelines and concrete-lined tunnels. For example, the two existing major conduits conveying wastewater to the existing Deer Island treatment plant (the Boston Main Drainage Tunnel and the North Metropolitan Relief Tunnel) are concrete-lined tunnels that have been in operation since 1968. To date, there are no known problems with the concrete.

Concrete has been used successfully for years in large-diameter sewerage applications. It is the only material with sufficient prior use to demonstrate its ability to provide uninterrupted service throughout the life of the project. Concrete also provides the following advantages:

- It is resistant to corrosion.
- It is resistant to erosion.
- It retains its hydraulic conveying property (friction factor).
- Slugs of air can enter the pipeline without the pipeline becoming buoyant.

Therefore, the conduit material, which will be exposed to untreated wastewater and salt water, will be concrete.

6.2.2 SELECTED CONDUIT ALTERNATIVES FOR DETAILED EVALUATION

Three alternatives have been selected for detailed evaluation. Alternative 1 is a single deep rock tunnel with vertical access shafts located on Nut Island and Deer Island. The tunnel would be lined with concrete.

Alternative 2 is a combination marine pipeline and deep rock tunnel. A single concrete pipeline would be constructed from Nut Island to Long Island. Between Long Island and Deer Island, a single deep rock tunnel, lined with concrete, would complete the inter-island conduit. Vertical access shafts would be located on Long Island and Deer Island.

Alternative 3 is a combination sunken tube and deep rock tunnel. A single concrete-lined sunken tube would be constructed from Nut Island to Long Island. Between Long Island and Deer Island, a single deep rock tunnel, lined with concrete, would complete the inter-island

Vertical access shafts would be located on Long Island and Deer Island.

Refer to Section 7.0 for the detailed evalution of the three conduit alternatives.

6.3 SOUTH SYSTEM PUMPING STATION

6.3.1 SCREENING EVALUATION

Location

It is technically possible to locate the pumping station on Nut Island or on Deer Island. The Deer Island location is preferred because the necessary pumping station support facilities will be constructed on Deer Island as part of the support facilities for the new wastewater treatment plant. The principal support facilities include redundant sources of electrical power, spare parts storage, and maintenance facilities. If the pumping station were located at Nut Island, separate support facilities would have to be constructed.

Variable-Speed Drives

The South System Pumping Station must be capable of pumping flows ranging from 80 mgd to 360 mgd. To handle this wide range of flows and resulting wide variation in heads, variable-speed pump drives are required. Three possible alternatives include diesel engines, electric motors with variable-frequency drives, and electric motors with eddy-current couplings.

Diesel engines are screened from further consideration because MWRA is committed to utilizing electric motors whenever practical. This will result in quieter operations and, with redundant electric power supplies available, a high level of reliability.

6.3.2 SELECTED PUMPING STATION ALTERNATIVES FOR DETAILED EVALUATION

The South System Pumping Station will be located at Deer Island. Two alternative variable-speed drive systems are evaluated in more detail. One alternative consists of constant-speed electric motors connected to eddy-current couplings. The other alternative consists of variable-frequency drives connected in series with electric motors.

These two alternatives are evaluated in detail in Section 7.0.

Section 7

7.0 DETAILED EVALUATION OF ALTERNATIVES

Three alternative inter-island conduits and two alternative South System pump stations are developed and evaluated in detail in this section. These five alternatives passed the screening evaluation performed in Section 6.0, Development and Screening of Alternatives.

Major design bases for the inter-island transport system are presented in Section 7.1. The design bases include major factors common to the conduit or the pump station alternatives that are required to develop the conceptual designs.

The conceptual designs and the detailed evaluations of the three conduit alternatives and the alternative pumping station designs and their detailed evaluations are presented in Section 7.2. Evaluation criteria for all alternatives include environmental, technical, institutional, and cost considerations. These evaluation criteria are described in Section 4.3, Criteria for Evaluation of Inter-Island Transport System Alternatives.

7.1 DESIGN BASES

The following design bases are factored into the design of the conduit and pump station alternatives, as applicable.

7.1.1 DATUM PLANES

The base elevation to be utilized in the facilities plan is the MDC Sewer Datum. Various datum planes are used in the Boston area, most commonly Mean Sea Level Datum (USGS datum of 1929), Boston City Base, and the MDC Sewer Datum. The following table presents the relationship of the various datums to the MDC Sewer Datum.

DATUM PLANES

To convert from	To	Add
USGS Datum	MDC Sewer Datum	105.62 ft
Boston City Base	MDC Sewer Datum	99.97 ft

7.1.2 TIDE LEVELS

Commonly accepted wastewater treatment plant design guidelines indicate that treatment

facilities must be protected against structural and equipment damage during a 100-year storm event.

The Boston Main Drainage Report, prepared by Camp Dresser and McKee in September 1967, lists the highest tide of record in Boston Harbor as 115.75 ft (16 April 1851) and the highest tide of record between 1922 and 1963 as 115.0 ft (29 December 1959). This report also estimates an average rate of sea level rise of 0.014 ft per year in Boston Harbor. Based on this rise, the projected annual highest tides are expected to increase 1.1 ft by the year 2020. Allowing for this increase in sea level, treatment components will be designed around a 100-year flood level of elev. 117.0 ft for Deer Island and elev. 122.0 ft for Nut Island.

7.1.3 FLOWS

Flows were developed on the basis of individual estimates for domestic users, major and minor nondomestic users, infiltration/inflow (I/I), and storm runoff. A summary of flows for the design year 2020 is presented in Table 7.1.3-1.

Domestic wastewater flow projections are based on population projections within the MWRA service area multiplied by a per capita flow contribution. A per capita wastewater flow of 65 gallons per day (gpd) was used for the study. This estimate is based on 85 percent return of the average 76-gpd water consumption in the MWRA service area.

TABLE 7.1.3-1

South System Flows (mgd)

	Minimum day	Average	Maximum day	Peak hour
Low groundwater conditions				
Wastewater	55	85	120	170
I/I	25	25	115	180
Total	80	110	235	350
High groundwater conditions				
Wastewater	55	85	120	170
I/I	145	145	235	300
Total	200	230	355	470
Hydraulic capacity of High Level Sewer				360

Major nondomestic users are defined as the users of MWRA's system whose records are available from the Industrial Waste Control Program. These users include manufacturing establishments, large institutions such as hospitals and schools, and large service companies such as laundries.

Minor nondomestic users include all other businesses in the service area. The wastewater contribution of this group is predominantly driven by employee usage.

I/I to Nut Island was determined by analyzing flow data. The data clearly revealed two distinct periods: high groundwater conditions and low groundwater conditions. During the nominal 4-month wet weather period, approximately February through May, groundwater levels and I/I are high. During the balance of the year, I/I amounts are lower.

For a more detailed description of the development of flows, refer to Secondary Treatment Facilities Plan, Volume III, Treatment Facilities, Section 3.

In determining the peak design capacity of the inter-island transport system, it was necessary to consider upstream flow constraints. The High Level Sewer (HLS), the main trunk line that transports wastewater to Nut Island, has a peak hydraulic capacity of 360 mgd. Therefore, the inter-island transport system will be designed for this maximum capacity of 360 mgd. As shown in Table 7.1.3-1, the peak hourly flow exceeds the hydraulic capcity of the HLS, and the major component of the peak hourly flow is I/I. The MWRA has instituted an I/I management program and one of the goals of this program is to reduce I/I.

In summary, the inter-island transport system will be designed to handle flows from 80 mgd to 360 mgd.

7.1.4 VELOCITIES

An acceptable range of velocities should be maintained in the conduit under all flow conditions. High velocities increase the potential for erosion of the conduit lining; separation of flow at turns, resulting in cavitation damage to the lining; excessive hydraulic head loss, resulting in increased pumping costs; hydraulic surging (water hammer) during startup and shutdown of pumps; and flow control stability problems. Low velocities require larger, more expensive conduits because of the increased potential for excessive deposition of organic and inorganic material normally suspended in the wastewater.

A maximum velocity of 10 feet per second (fps) or less is desirable for concrete conduits conveying wastewater. A minimum velocity of 2 fps is desirable, to keep sand and grit suspended; however, 1 fps is acceptable if sand and grit have been removed. Because new grit-removal facilities will be constructed on Nut Island ahead of the inter-island conduit, an acceptable range of velocities is 1 fps to 10 fps.

7.1.5 FRICTION HEAD LOSSES

Wastewater in the inter-island conduit will flow full under all operating conditions and lose head due to friction losses. A pumping station will be required to overcome the friction loss plus any static lift requirements due to water surface elevation differences between Nut Island and Deer Island. Static lift is a fixed value and is easily determined. Friction loss, however, must be determined based on experience.

Friction head losses were evaluated utilizing the Darcy-Weisbach equation. The Darcy-Weisbach equation is $H = f(L/D)(V^2/2g)$ where

H = friction head loss, ft

f = friction factor

L = length of conduit, ft

D = diameter of conduit, ft

V = velocity of flow, ft/sec

g = acceleration due to gravity, ft/sec^2

Determination of the maximum expected head loss is important because it affects the size of pumping station electrical equipment and determines the depth below grade to which the pumps must be set. It is important to select a conservative, yet realistic, friction factor. Since the pumps are required to operate throughout the life of the project, the friction factor must also take into account aging of the conduit walls.

Two approaches to selecting a friction factor were made. First, a review of the literature indicates that the friction factor for concrete conduits varies from 0.012 to 0.020 for the diameter and flow conditions anticipated for the inter-island conduit. The second approach was to calculate the friction factor from actual field test measurements (Havens & Emerson/Parsons Brinckerhoff, 1984) for MWRA's two existing major concrete-lined conduits conveying wastewater to Deer Island since 1968. The North Metropolitan Relief Tunnel is 10 ft in diameter and approximately 21,000 ft long. The Boston Main Drainage Tunnel is 11.5 ft in diameter for approximately 24,000 ft and 10 ft in diameter for approximately 14,000 ft. These diameters, lengths, and concrete materials match the anticipated inter-island conduit. Therefore, these results are applicable and, by definition, take into account aging. A review of hydraulic test data for these tunnels indicated a friction factor variation from 0.018 to 0.022.

Based on the results of the literature survey and the field testing, a nominal friction factor of 0.020 will be used for facilities planning. The friction factor will be reevaluated during final design.

Section 7.1.5 References

Havens & Emerson/Parsons Brinckerhoff. 1984. Deer Island Facilities Plan, Volume I, Fast-Track Improvements, Chapter 20. Metropolitan District Commission.

7.1.6 SLOPE

The inter-island conduit will convey untreated wastewater. Screening and grit-removal facilities will be provided on Nut Island, upstream of the conduit. Therefore, settleable material such as grit and sand should not enter the conduit, and deposition within the conduit should not be a problem. However, because the conduit is designed to operate continuously throughout the project life and beyond, and because there is no simple means of cleaning the conduit, extra precautions against deposition at inaccessible areas are warranted.

Because the conduit is accessible only at its origin on Nut Island and at its terminus on Deer Island, it will be a design requirement that the conduit slope continuously downward in the direction of flow. There will be no low points in the conduit.

7.1.7 GEOLOGIC CONDITIONS

The geology of Boston Harbor comprises surficial soils of glacial origin varying in thickness up to approximately 100 feet, overlaying an irregular bedrock surface that is predominantly argillite.

Soil

The surficial deposits in the offshore areas of Boston Harbor generally consist of a dense primary or basal till forming a thin veneer over the bedrock surface, which is often overlain by a marine clay ("Boston blue clay" or glacial rock flour) up to several tens of feet thick.

The most prominent glacial features in the harbor are the drumlins, which consist of a till having a generally cohesive clayey/silt matrix containing granular pieces from sand to boulder size. Cobbles, pebbles, occasional boulders, along with sandy or gravelly layers are often interbedded with the more homogeneous materials. Some drumlins directly overlay bedrock, while others overlay older glacial sediments. Many drumlins form the core of harbor islands, while others are submerged and buried or surrounded by later marine clays. Marine coastal forces have eroded, remolded, and redeposited these glacial sediments throughout the harbor area.

At Nut Island, the area of the proposed tunnel shaft occupies what is believed to be the remnant of a partially eroded drumlin consisting of a moderately-dense to dense till that is over 90 ft thick.

The rock surface along the inter-island conduit route between Nut Island and Deer Island is highly irregular, forming localized peaks or shoals. Conversely, the deep bedrock valleys are

mainly filled with soft clays, silts, and/or till with thicknesses exceeding 100 ft in isolated areas. In many areas, overlaying the marine clay is a 2- to 10-ft-thick layer of loose sand and/or soft mud.

At Deer Island, the South System Pumping Station shaft is located near the south flank of the central drumlin. Here the bedrock is overlaid by 90 ft of soil comprising approximately 35 ft of moderately soft to stiff till at the base, followed by 30 ft of soft to firm clay, and subsequently overlaid by about 30 ft of mostly cohesive, very stiff glacial outwash material.

Bedrock

The bedrock geology of the Boston Harbor area is dominated by the slightly metamorphosed and often complexly folded and faulted argillite known as the Cambridge Formation. This rock is generally characterized as very thinly bedded, laminated to occasionally nonbedded, fine grained, well indurated, and, with few exceptions, moderately hard to hard.

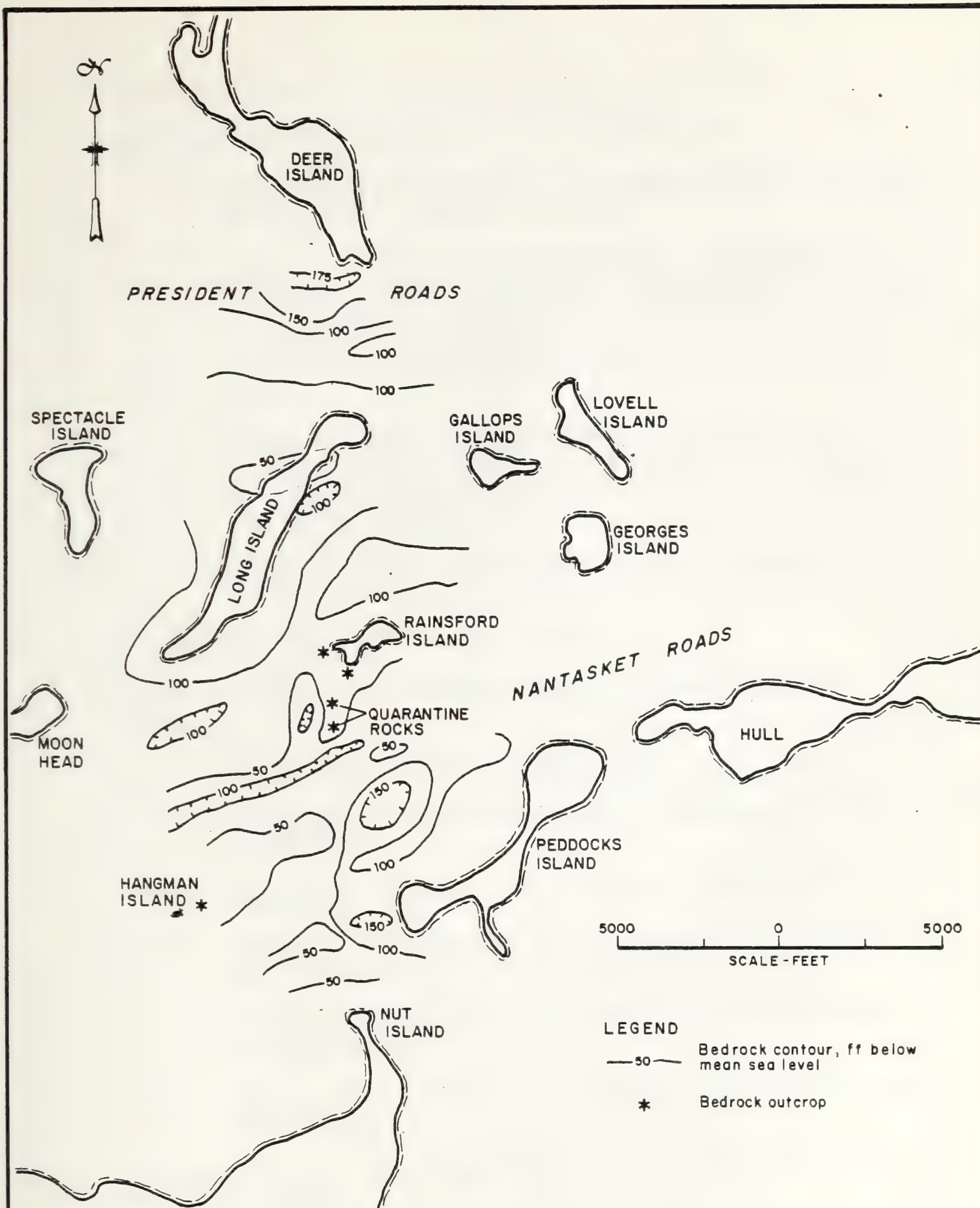
Within the Cambridge Formation are well-documented, localized areas of kaolinized bedrock. At one location or another, all the rock types (argillite, sandstone, conglomerate, diabase, etc.) have been affected by this alternation. Consequently, it is assumed that this phenomenon may be observed randomly along the inter-island conduit route.

In the vicinity of the proposed tunnel shaft at Nut Island, the top of argillite bedrock is at elev. 43 ft. Observations from rock core indicate that the bedding generally dips at 45 degrees from the horizontal with closely spaced, parallel to subparallel jointing. In many cases the fractures have been rehealed by calcite, and exposed joint surfaces show very little weathering.

The inter-island portion (Nut Island to Deer Island) shows a very irregular bedrock surface configuration with areas of exposed bedrock on some harbor islands (Rainsford Island, Quarantine Rocks, and Hangman Island). Some of the deeper valleys or holes expressed by the bedrock surface range from elev. -45 ft to elev. -60 ft in the vicinity of Peddock's Island and President Roads, respectively. Figure 7.1.7-1 illustrates the bedrock contours between Nut Island and Deer Island.

Along the inter-island conveyance route, the predominantly argillite bedrock is intruded by igneous (diabase/basalt) dikes or sills, as evidenced by an exposure on Hangman Island. The possibility of encountering tillite or conglomerate is enhanced by the occurrence of such rock in isolated areas on either side of the inter-island route. The argillite bedding in this area was observed to vary between 45 degrees to vertical, with evidence of complex folding and shearing. As projected from observations on the mainland, several major faults are expected to transect this area. The regional strike of geologic structures (i.e., faults, major plunging folds, and bedding) is expected to range between N45° E and N80° E.

In the vicinity of the South flow pumping station shaft on Deer Island, the top of bedrock is at elev. 33 ft. The argillite bedding dips at 45 to 50 degrees from the horizontal and may generally be characterized in the same manner as previously described for Nut Island.



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 7.1.7-1
INTER-ISLAND BEDROCK CONTOURS

7.1.8 PUMPING STATION

The following criteria will be used to lay out the South flow pumping station:

- Motors and drives - Motors and drives will be located above flood level and connected through intermediate vertical shafting to the pumps.

- Pumps - Pump type will be single-stage, single-suction, vertical dry-pit, standard sewerage pumps. Maximum flow per pump, as limited by casting sizes, will be 125,000 gallons per minute (gpm). The pump station will be designed to handle the range of flows from the minimum design flow to the peak design flow. In addition to the number of pumps required to handle the peak design flow, two spare pumps will be installed.

- Electrical power supply - To prevent a disruption in operation due to a power failure, two separate and independent sources of electric power will be provided to the pumping station. The internal power distribution will be designed such that no single failure would shut down the station.

- Wetwells - Wetwells will be divided into two sections to allow cleaning and maintenance to be performed while the station is in operation.

7.1.9 CONSTRUCTION SEQUENCE AND SCHEDULE

The following interface dates have been established by the court-ordered implementation schedule:

1. July 1994 - Construction of the new outfall completed

2. October 1994 - New outfall to begin accepting flow from the existing Deer Island treatment plant

3. December 1994 - Construction of inter-island transport system completed

4. March 1995 - New outfall to begin accepting flows from the existing Nut Island treatment plant through the inter-island transport system

5. July 1995 - Construction completed and operation to begin of the new primary treatment facilities at Deer Island

6. December 1999 - Construction completed and operation to begin of the new secondary treatment facilities

In consideration of the above dates, the system must be designed and constructed to allow phased operation as follows:

Phase I - Transport the effluent currently discharged at Nut Island and/or the effluent currently discharged at Deer Island to the new outfall location. Phase I must be complete by March 1995.

Phase II - Transport all wastewater to new primary treatment facilities at Deer Island and convey the effluent to the new outfall location. Phase II must be complete by July 1995.

Phase III - Transport all wastewater to new primary and new secondary treatment facilities at Deer Island and convey the effluent to the new outfall location. Phase III must be complete by December 1999.

The court-ordered implementation schedule requires completion of the new outfall by July 1994. This date was based on the new outfall being located approximately 3.5 miles from Deer Island. It is important to understand that if the distance to the new outfall is increased beyond the original 3.5 miles, it may not be possible to complete construction by July 1994. Then, depending on the final approved outfall location, there may be no need to phase construction of the inter-island transport system.

7.2 IDENTIFICATION OF ALTERNATIVES

7.2.1 INTER-ISLAND CONDUIT ALTERNATIVES

Tunnel

A tunnel with a finished inside diameter of 11 ft would be constructed in competent rock approximately 200 ft to 300 ft below sea level. The deep rock tunnel would be connected to new headworks facilities at Nut Island and to the new South System pumping station at Deer Island by vertical drop shafts. One vertical shaft 16 ft in diameter would be located at each island. All wastewater passageways would be lined with concrete. The tunnel would follow a straight line from Nut Island to Deer Island, a distance of approximately 24,800 ft. The plan and sections of the proposed tunnel are shown in Figures 7.2.1-1 and 7.2.1-2.

The tunnel would be constructed beginning at Deer Island. The construction sequence would proceed as follows:

1. Construction of the vertical shaft on Deer Island by excavating from grade down to the tunnel invert

2. Excavation of the 24,800-ft-long tunnel from Deer Island toward Nut Island, removing tunnel spoils from the vertical shaft on Deer Island

3. Construction of the vertical shaft on Nut Island and completion of this shaft before the tunnel reaches Nut Island

4. Lining of the tunnel system with concrete

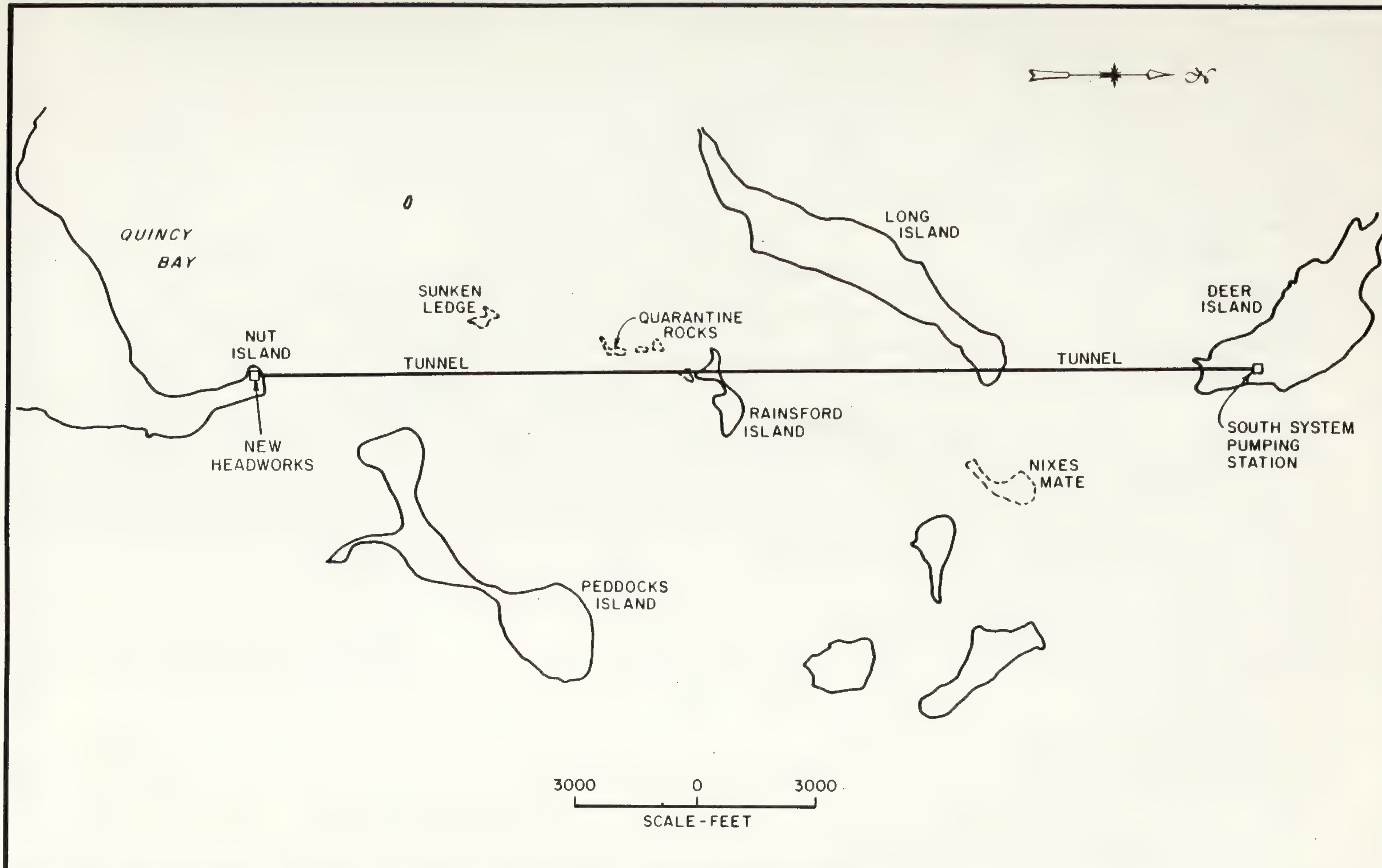


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FIGURE 7.2.1-1
TUNNEL - PLAN

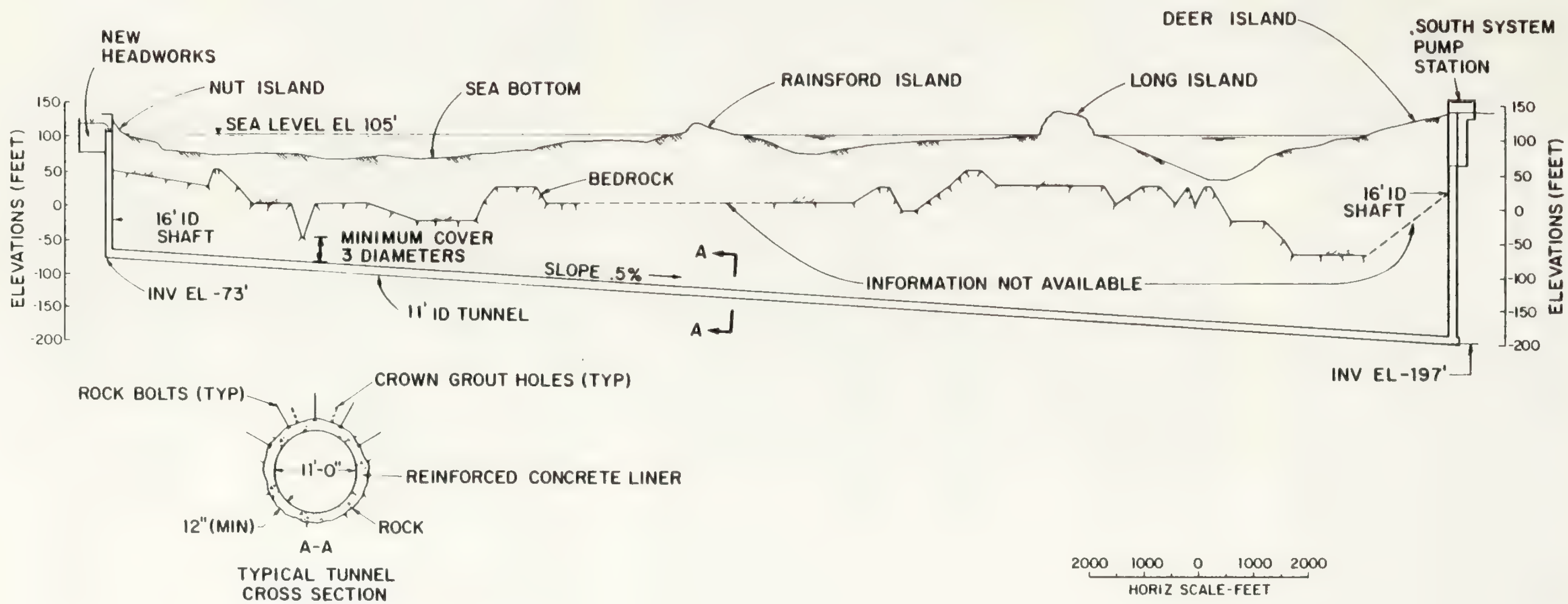

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FIGURE 7.2.1-2
TUNNEL - SECTION

At the proposed vertical shaft locations, the geologic profile consists of 80 to 100 ft of glacial soils, mainly in the form of clays or till overlaying argillite bedrock. Soil support would be required during shaft excavation. Steel sheet piling may be driven through the soil into the rock prior to excavating, or a concrete caisson may be driven into the soil as excavation proceeds. Excavation of the clay soils, while potentially difficult to handle, especially when wet, should proceed with relative ease. On the other hand, the glacial till can be quite hard and difficult to excavate. A combination of small machine and power spades would probably be used to loosen the soils, which would then be lifted by bucket to the surface. Bedrock excavation should not be unusually difficult to accomplish with traditional drill and blast techniques.

The potential for groundwater to enter the upper portion of the shaft excavations would depend on the permeability of the soil layers penetrated. Groundwater inflow can be expected through the near-surface layers of sand or gravel, but it should not be significant through the clay or till soils. Any trapped water that exists near the soil-bedrock interface would likely enter the excavation on first exposure, then decrease markedly with time.

Design considerations stipulate that the tunnel section be located a minimum depth below the lowest point in the bedrock surface. For conceptual design and cost estimating, a 30-ft burial depth is assumed to be adequate to minimize the effect of stress concentrations in the overlying bedrock due to the presence of the tunnel. (This criterion will be reevaluated during final design.) For the inter-island alignment shown in Figure 7.2.1-2, miminum cover occurs near Nut Island. Since the tunnel would be maintained at a constant slope of 0.5 percent or less, at certain locations along the alignment the bedrock cover over the tunnel would increase to nearly 200 ft. This slope would facilitate the removal of all leakage into the tunnel during construction and would minimize deposition of solids in the tunnel during operation. Solid deposition may occur at the transition from the tunnel to the shaft on Deer Island, but this area is accessible for cleaning with a clamshell if necessary.

The predominant rock type, Cambridge argillite, is a medium-hard rock. Unconfined compressive strength test values vary from 4 kips per square inch (ksi) to to 45 ksi, with an average value of 20 ksi. Average compressive strength values were not established for other minor rock types likely to be encountered along the alignment, such as diabase intrusions, tillite, or conglomerate. Based on information to date on rock strength, hardness, and bedding characteristics, the tunnel excavation should proceed at a moderate rate. It is anticipated that the tunnel would be mined by a tunnel boring machine (TBM) unless detailed field studies conducted during the design phase of the project determine that the nature of the rock along sizable extents of the alignment is not conductive to TBM mining. For example, conglomeritic rock or kaolinized zones likely would have an adverse effect on the progress and economics of machine boring.

Previous tunnel experience in Boston Harbor has demonstrated that rock supports probably would be required for portions of the tunnel length. Weaknesses in the argillite can result from faults, diabase intrusions, bedding configurations, and kaolinized zones. Rock support requirements along a previously constructed Boston Basin tunnel have varied from less than 1 percent of the length to an extreme case of 50 percent of the length, with an average of 20

percent. Improvements in tunneling technology over the past 20 years have resulted in a reduction in the overall need for rock support. For the present, therefore, rock bolting and grouting have been estimated for approximately 15 percent of the length.

Major inflows of water into the tunnel through the bedrock are not anticipated during construction unless severely faulted or otherwise altered zones of rock are encountered. In general, any water seepage entering the tunnel is expected to be brackish and would be controlled during construction by channeling back down the tunnel invert to sump locations.

The tunnel would be lined with either precast concrete sections or cast-in-place concrete. The concrete lining is included to provide a smooth tunnel wall to minimize the friction head loss in the tunnel, which in turn minimizes the required tunnel size and pumping costs. Final liner design, including thickness and reinforcing, would be based on an evaluation of the internal and external pressures and the load-transfer characteristics of the bedrock. For conceptual design and cost estimating, a 12-inch-thick cast-in-place reinforced concrete liner has been selected. Therefore, the TBM would excavate a 13-ft-diameter bore; after placement of the liner, the finished tunnel diameter would be 11 ft. Access for overbreak grouting would be provided; however, the nature of the argillite and TBM mining techniques should combine to minimize overbreak.

It is anticipated that the tunnel spoils would be, for the most part, in the particle-size range of coarse gravel to medium sand with some fine sand and silt-size particles. Specific uses for the spoils on Deer Island, such as structural fill, berm fill, or concrete aggregate, would be determined during the design phase.

Pipeline/Tunnel

The pipeline/tunnel alternative is a combination marine pipeline and deep rock tunnel. A concrete pipeline with an 11-ft inside diameter would be constructed 14,300 ft across Quincy Bay between Nut Island and the southern tip of Long Island. To complete the inter-island conduit, a tunnel with an 11-ft finished inside diameter would be constructed 12,600 ft under the Boston shipping channel (President Roads) between Long Island and Deer Island. Vertical shafts 16 ft in diameter would be located on Long Island and Deer Island. The plan and sections of the proposed pipeline/tunnel are shown in Figures 7.2.1-3 and 7.2.1-4.

The tunnel portion and the pipeline portion of the inter-island conduit would be constructed in parallel. However, since different construction methods are required, each portion would proceed independently.

Construction of the tunnel portion and the two vertical shafts would be similar to that described in the preceding subsection discussing construction of the tunnel alone. The sequence of construction would proceed as follows:

1. Construction of the vertical shaft on Deer Island

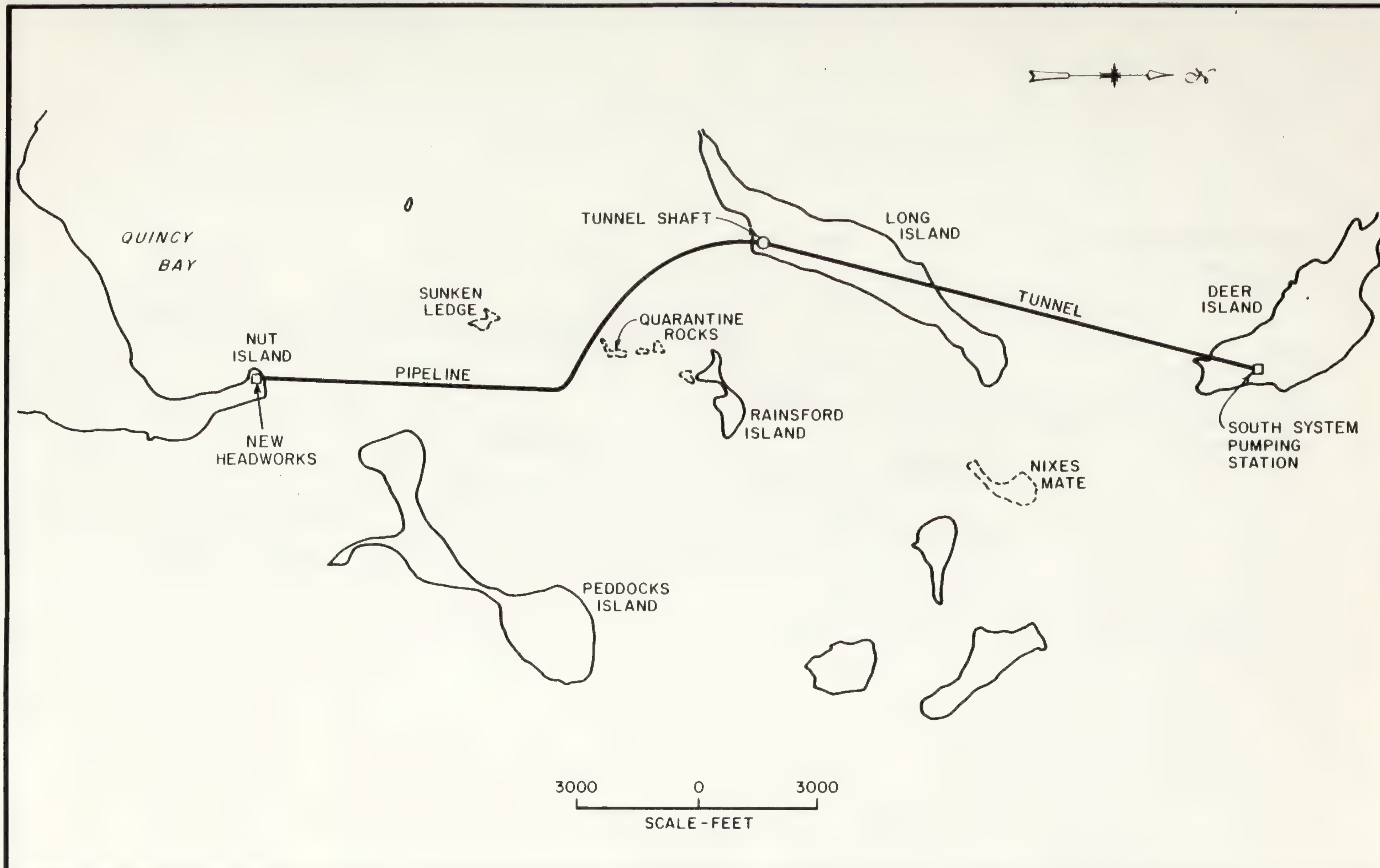

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FIGURE 7.2.1-3
PIPELINE/TUNNEL-PLAN

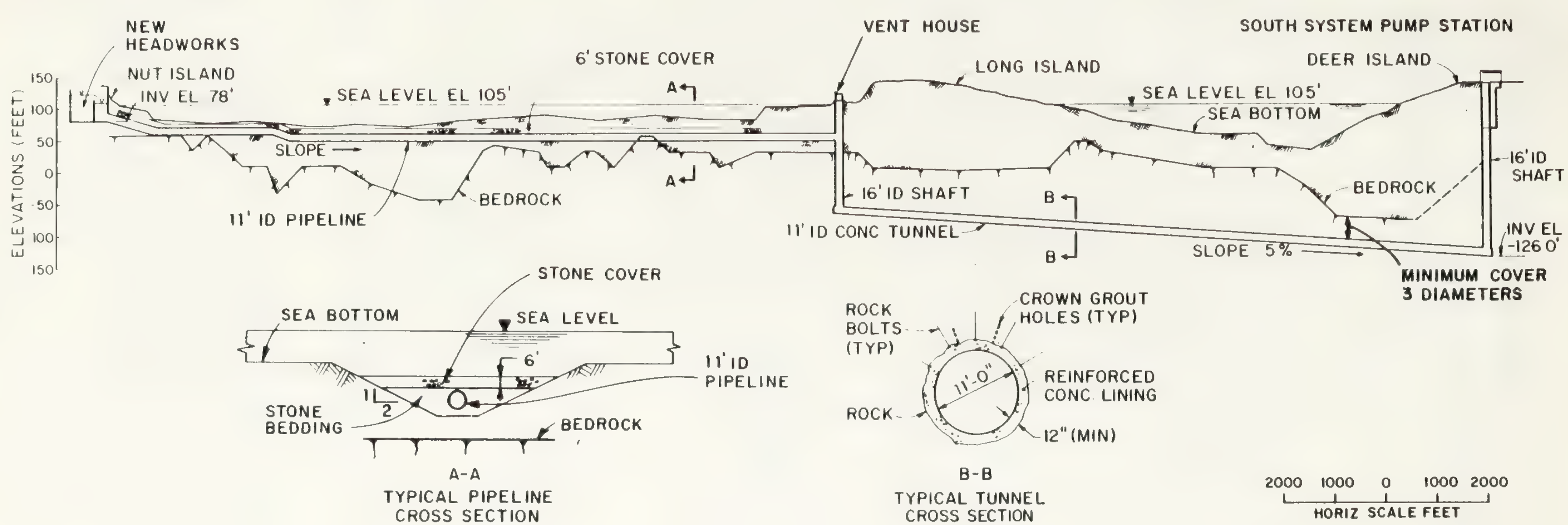

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FIGURE 7.2.1-4
PIPELINE/TUNNEL-SECTION

2. Excavation of the tunnel from Deer Island toward Long Island, removing tunnel spoils from the vertical shaft on Deer Island

3. Construction of the vertical shaft on Long Island and completion of this shaft before the tunnel reaches Long Island

4. Lining of the tunnel system with concrete

The geotechnical considerations and method of constructing the tunnel would be similar to those described in the subsection on the tunnel. In summary, construction at the vertical shafts would require driving steel sheet piling or a concrete caisson into bedrock to support the soil. Soil would be excavated by bucket, and rock removed by drill and blast techniques. The tunnel would be bored to a 13-ft diameter by a TBM. After removing the TBM, a 12-inch-thick reinforced concrete liner would be placed, resulting in an 11-ft-diameter finished tunnel. Again, all tunnel spoils would be disposed of or used on Deer Island. The pipeline portion of the inter-island conduit would consist of a concrete pipe with an 11-ft inside diameter. The pipe would begin at the new headworks facilities at Nut Island, cross Quincy Bay, and end at the vertical shaft on the southern end of Long Island. The pipeline route was selected to avoid areas where bedrock is high and sand bars and shallow-water areas. Avoiding bedrock where possible would minimize underwater blasting, which is prohibitively expensive. Avoiding sandbars and shallow areas would minimize excavation quantities.

Since the soils to be excavated are predominantly clays or widely graded tills with significant percentages of gravel or larger-size cobbles, the excavation would likely be done by clamshell or mechanical dragline and transferred to barges for disposal at an ocean foul area located approximately 20 miles east of Deer Island. Hydraulic dredging is not considered a viable excavation technique because of the problems associated with both excavating and disposing of these clay or till soils. The fine-grained soils would cause siltation in the water, and the boulder-size pieces might affect the dredge cutters.

The steepness of the underwater cut slopes would vary depending on the strength of the soils at a particular location and the length of time the cut remains open prior to pipe placement and backfilling. In the softer, lower-strength soils, the slopes may be as flat as 4H:1V, while the stiffer soils may be cut much closer to vertical. Therefore, it is estimated that the average slope cut would be on the order of 2H:1V.

Evaluations of the in situ clays and till have indicated that soil consolidation under the pipe loadings would not be sufficient to cause undue settlement of the sections or distress at the connections.

To provide uniform lateral and vertical support for the pipeline, the trench bottom would be overexcavated approximately 2 ft vertically and 10 ft laterally and subsequently backfilled. The bedding and backfill would be high-quality granular materials such as processed rock or graded gravel, suitably coarse for placement underwater yet fine enough to provide uniform support for the pipe. Typically, a material with a maximum particle size on the order of 2 in would fulfill the above requirements.

To protect the pipe against damage from anchor dragging and scour from wave and tidal forces, a 6-ft-thick, graded armor-stone layer of rock with a minimum individual stone size of 18 in. is required. Within the surf zone near Nut Island and Long Island, the layer thickness should be increased to 10 ft. Adequate scour protection and lateral support of the pipe would require extending the backfill and armor-stone materials a distance of approximately 20 ft laterally to either side of the top of the pipe. Also, the top of the armor-stone layer should be established at or below the existing sea bottom.

The excavation in the bedrock section would require underwater blasting to establish the trench grade. Due to the competent nature of the rock, the cut slope would likely be established at a nearly vertical slope. To account for overbreak and bedding plane irregularities, a 1H:4V slope was assigned. The remaining geometrical and material considerations in the rock excavation segment such as those related to trench bedding, backfilling, and scour protection would be the same as for the trench in the soil sections.

The 11-ft-diameter reinforced concrete pipe would most likely be manufactured off-site in 16-ft to 24-ft lengths and shipped to Boston via barge. The offshore pipe would be put into place using barge-mounted cranes and divers. In the area near the shoreline of Long Island and Nut Island, a trestle would be constructed and the pipe placed by cranes operating on the trestle.

Figure 7.2.1-4 illustrates the profile of the pipeline/tunnel inter-island conduit. A system high point would occur at the Long Island vertical shaft, which would trap gases released from the wastewater. To prevent these gases from restricting the wastewater flow, vents would have to be provided directly over the Long Island shaft. Gas would be passed through activated-carbon filters located in a vent house and discharged to the atmosphere. The vent house would be approximately 20 ft in diameter and 10 ft high.

Sunken Tube/Tunnel

The sunken tube/tunnel alternative is a conduit constructed by a combination of sunken tube technology and deep rock tunnelling. A tube with an inside diameter of 11 ft would be installed 14,300 ft across Quincy Bay between Nut Island and the southern tip of Long Island. To complete the inter-island conduit, a tunnel with a finished inside diameter of 11 ft would be constructed 12,600 ft under President Roads between Long Island and Deer Island. Vertical shafts 16 ft in diameter would be located on Long Island and Deer Island. The plan and sections of the proposed sunken tube/tunnel are shown in Figures 7.2.1-5 and 7.2.1-6.

This arrangement is nearly identical to the pipeline/tunnel alternative. In both schemes, the tunnel portion between Long Island and Deer Island is identical. Between Nut Island and Long Island, the routing, trench conditions, and cover protection requirements of the sunken tube are identical to those of the pipeline. The only differences are the methods of manufacturing and installing the conduit.

For a description of the geology, construction sequence, and construction methods for the tunnel portion of this alternative, including the vertical shafts at Long Island and Deer

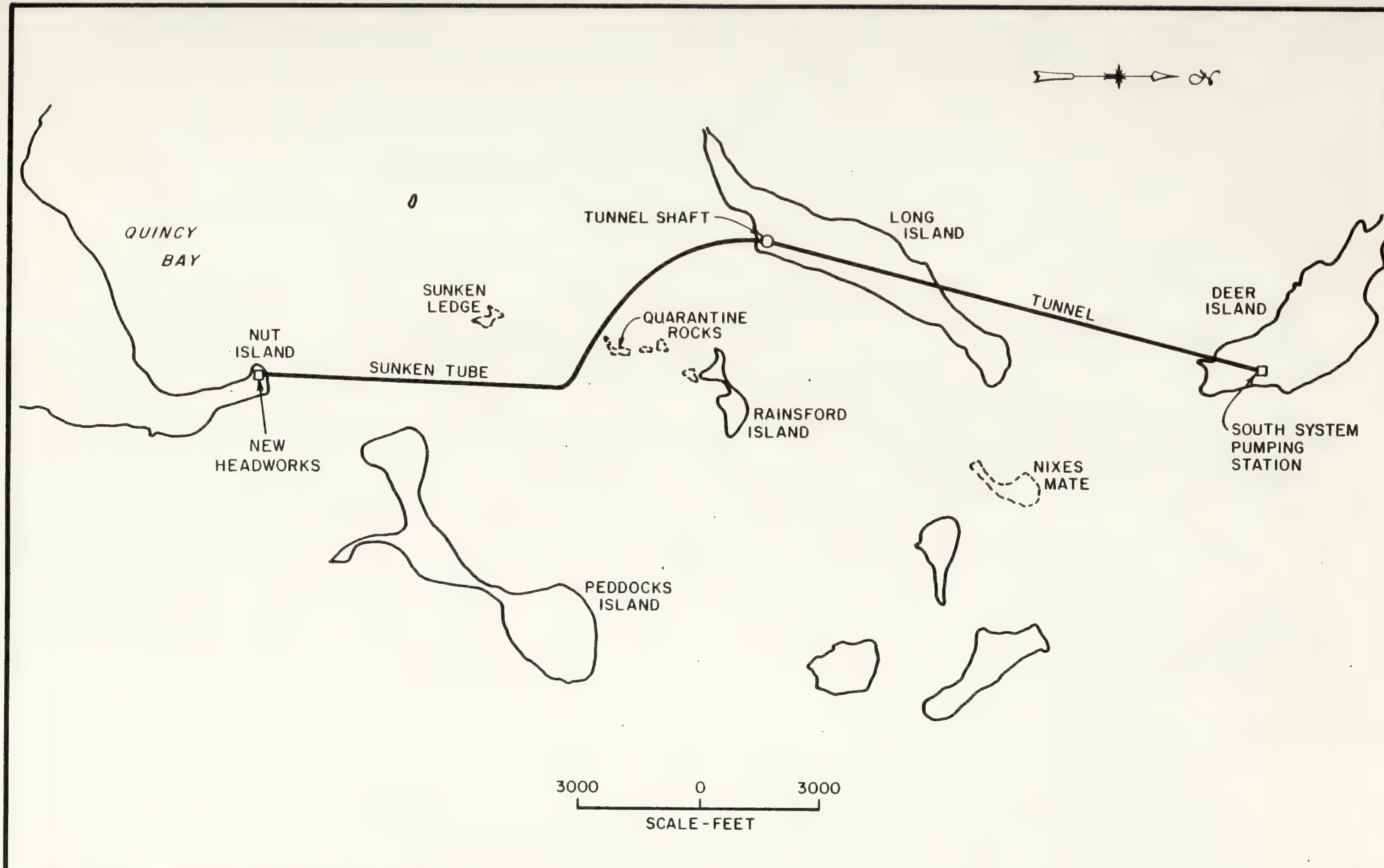

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FIGURE 7.2.1-5
SUNKEN TUBE / TUNNEL - PLAN

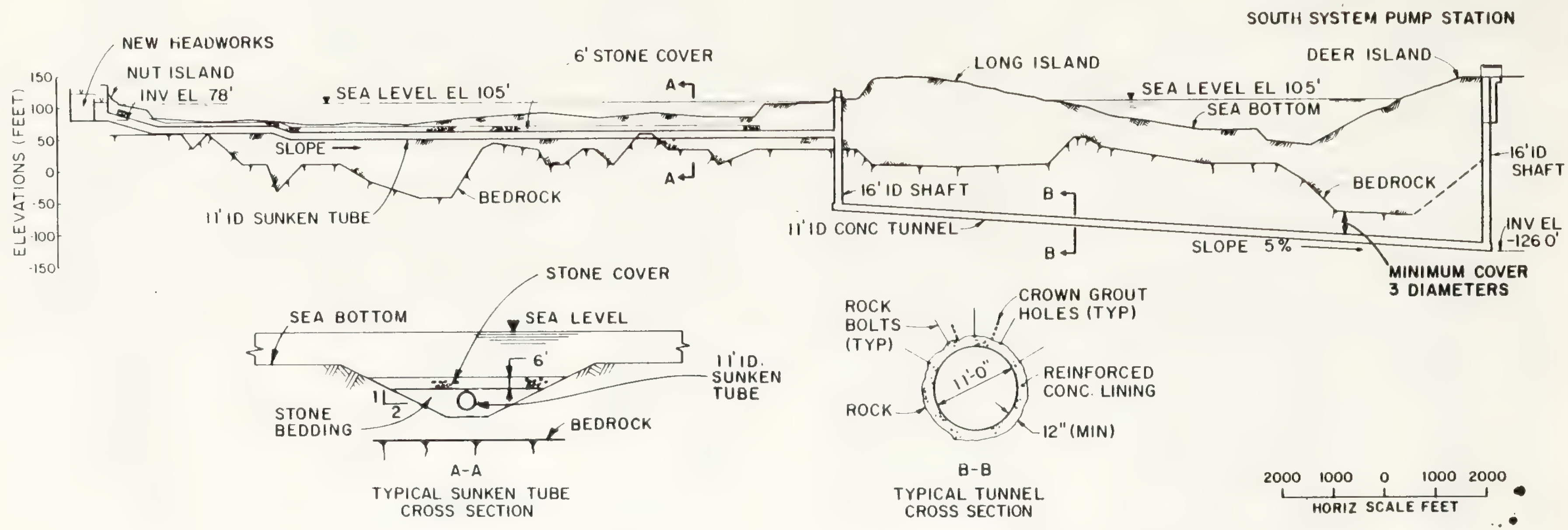

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FIGURE 7.2.1-6

SUNKEN TUBE / TUNNEL - SECTION

Island, refer to the previous subsection on the pipeline/tunnel alternative.

Sunken tube technology was developed for large-diameter highway tunnels constructed under waterways. Sunken tubes have been used extensively in the Chesapeake Bay area to move traffic under rivers and harbors along busy interstate highways.

Manufacturing of the tube would begin at a shipyard experienced with the fabrication process. First, a 40-ft-long cylinder would be fabricated by welding and rolling stiffened steel plates to the desired diameter. Diaphragms and form plates would then be welded to the outside to form compartments that would later be filled with concrete. This would complete one 40-ft-long module. Five modules would then be welded together to form a 200-ft-long tube. Next, reinforcing steel for the interior concrete lining would be erected inside the tube. To complete the steel fabrication, dam plates would be welded to each end to seal the tube. Finally, keel concrete would be placed in the bottom compartments. The tube would then be ready to be towed to the site.

An outfitting facility would be required in the Boston area to complete the tube construction. Interior and exterior concrete work would be done at the outfitting facility. The exterior concrete would serve as ballast and add the necessary strength to the tube. Inside, each finished tube would have a concrete wastewater passageway. For conceptual design and cost estimating, it was assumed that the Quincy shipyard would be used as the outfitting facility. If the Quincy shipyard is not available, a pier approximately 1,000 ft long and 40 ft wide with a maximum water depth of 20 ft would have to be constructed adjacent to a staging area of at least 3 acres.

As the tubes are being outfitted with concrete, the trench between Nut Island and Long Island would be prepared. The trench would be excavated by clamshell or mechanical dragline. Excavated material would be transferred to barges for disposal at an ocean foul area 20 miles east of Deer Island. After excavating the trench, granular material would be placed to provide a minimal 2-ft-thick bed. The trench would then be ready to accept the tube.

After it had been outfitted with concrete and its trench prepared, the tube would be towed to the placement site and sunk into the trench by placing ballast concrete in the outside compartments. To complete the crossing between Nut Island and Long Island, approximately 72 tubes would be placed. As each tube was lowered and jointed to tubes already in place the joint between the dam plates would be sealed, the dam plates removed, and the interior concrete lining completed between tubes. Concrete trucks would be barged over the trench as required to place ballast and final interior concrete. Subsequently, the trench would be backfilled and an armor-stone cover 6 to 10 ft thick would be placed on top of the tube for protection.

7.2.2 SOUTH SYSTEM PUMPING STATION ALTERNATIVES

The South System pumping station will receive the South System wastewater flow from the inter-island tunnel and deliver it to the new primary treatment facilities. The pumping station will be located at Deer Island. All pumps will be driven by electric motors serviced by two separate and independent sources of power. Two variable-speed pump-drive systems to

efficiently pump the wide range of design flows (80 mgd to 360 mgd) were evaluated: eddy-current couplings and variable-frequency drives. With either alternative, the pumping station would be similar. Only the equipment arrangement at the operating floor would vary. Plans and sections of the pumping station are shown in Figures 7.2.2-1 and 7.2.2-2.

The station will be located on the southern side of the island. An adjacent vertical shaft will hydraulically connect the facility to the inter-island tunnel from Nut Island.

The substructure extends from grade down to approximately elev. 40 ft. The superstructure roof extends to approximately elev. 200 ft. The plan area at grade is approximately 130 ft long by 70 ft wide, or approximately 9,000 ft^2 in area.

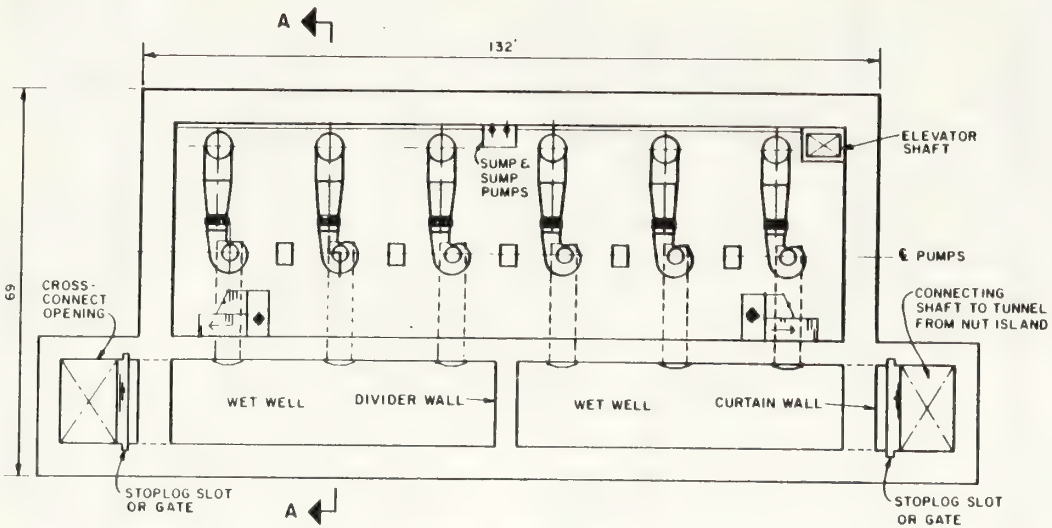
Construction of the pumping station would pose no unusual problems and would involve the following: driving sheet piling from grade into bedrock around the perimeter of the structure (slurry wall construction could be used as an alternative means of soil support); excavating the soil within the sheeting down to elev. 40 ft; pouring the concrete substructure, including foundation, walls, and floors; erecting the superstructure and setting the crane; and installing all mechanical and electrical equipment.

South System flow from Nut Island would enter the station from the inter-island tunnel at opposite ends of the structure. The vertical shaft mentioned above would terminate at one end of the structure and a cross-connection passing under the structure would terminate at the opposite end. The two connections would open into a wetwell area from which the station pumps would take their suction. The wetwell is sized to damp out surges, which could occur from sudden operating changes.

The wetwell would have a dividing wall, and stop log slots or sluice gates would be provided at each tunnel connection. This would permit isolation of half of the station from Nut Island, thus avoiding total disruption of service if the inlet area to the pumps should ever require maintenance.

Six pumps would pump the South System wastewater from the station wetwell area to the new Deer Island primary treatment works. The pumps are sized so that four pumps would be adequate to pump the maximum expected inflow. This provides two spares, allowing one to be on ready standby in the event that the other is down for maintenance. The pumps are vertical-shaft, dry-pit, mixed-flow type. Based on preliminary hydraulic analysis, six installed pumps would be the minimum number needed to provide efficient operation throughout the wide range of design flows and resulting heads. This will be confirmed during the detailed design phase.

Sluice gates would be provided on the suction side of the pumps to isolate the pumps from the wetwell. Sluice gates were selected over in-line valves for conceptual design and cost-estimating purposes. Operators for the sluice gates would be located on the operating floor, which is at grade. During detailed design, a more particular comparison of sluice gates and in-line valves will be performed.



PLAN AT PUMP FLOOR

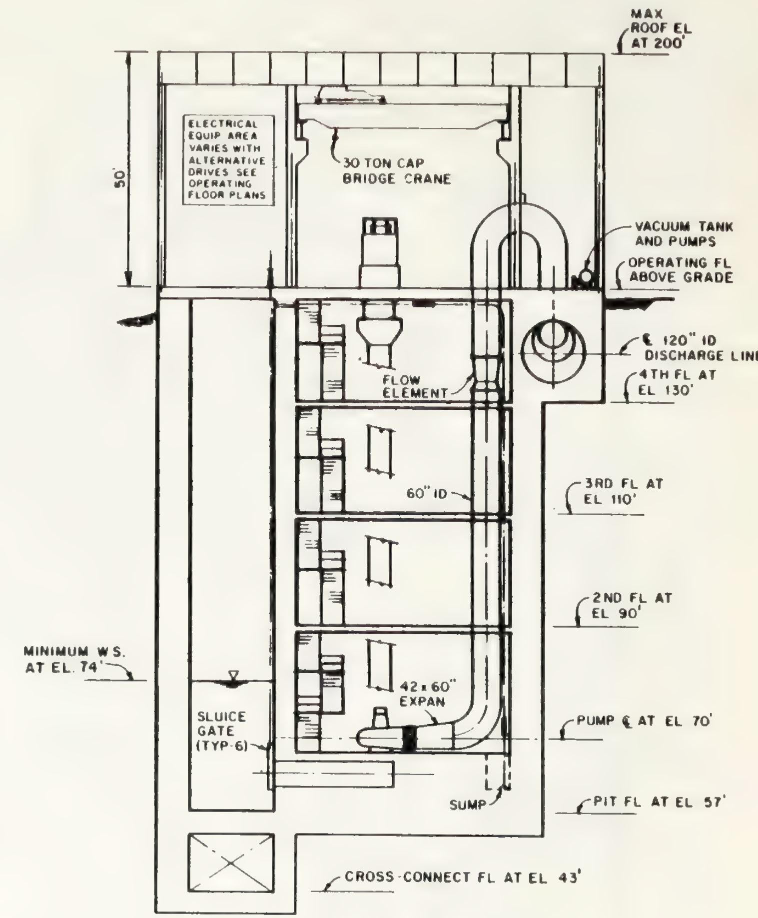


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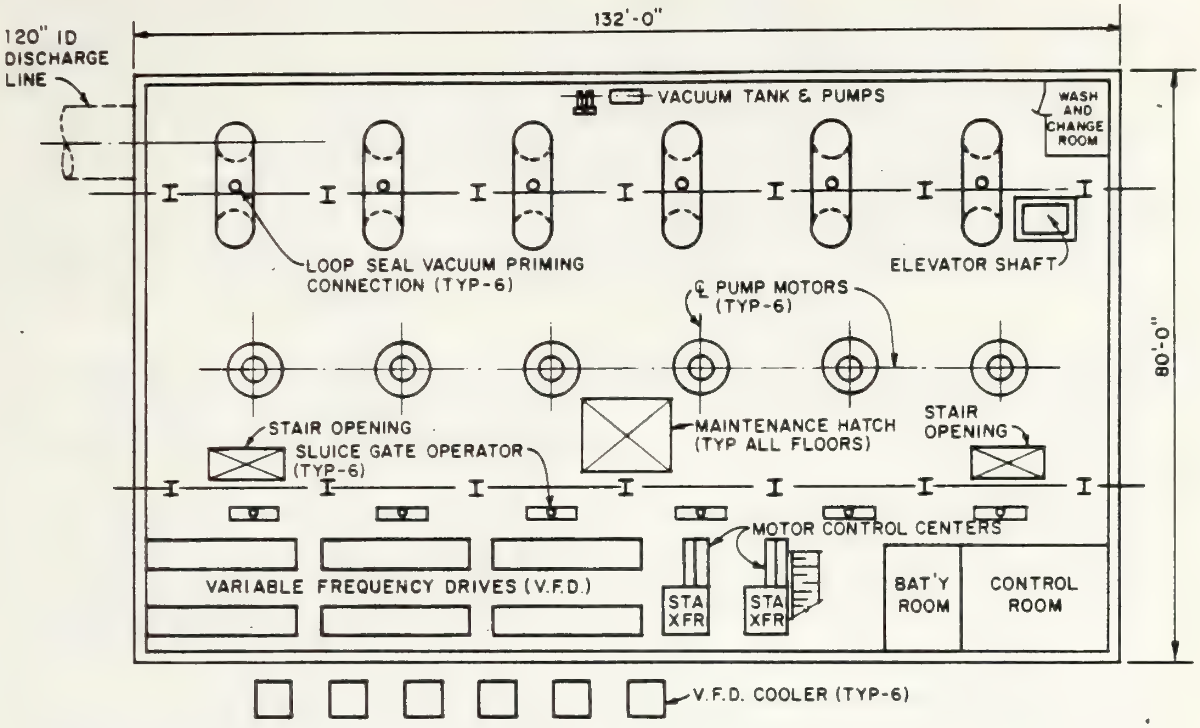
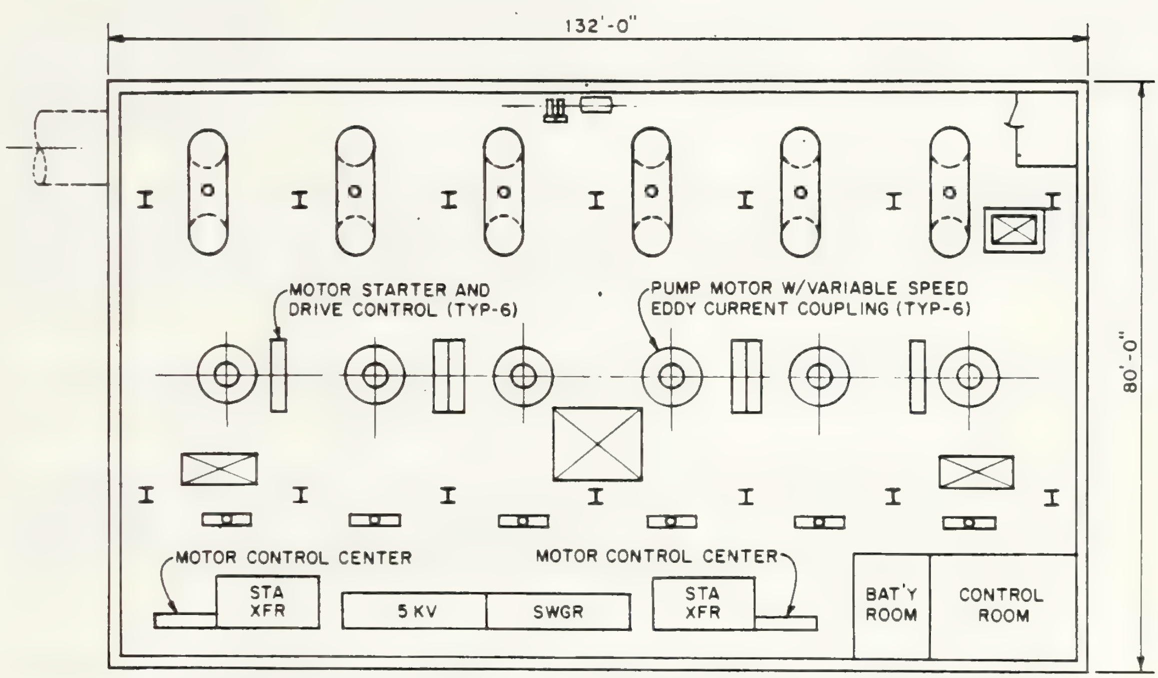
FIGURE 7.2.2-1
SOUTH FLOW PUMPING STATION



PLAN AT OPERATING FLOOR-(VARIABLE FREQUENCY DRIVE)



PLAN AT OPERATING FLOOR-(EDDY CURRENT COUPLING)

MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 7.2.2-2 SOUTH SYSTEM PUMPING STATION

The pumps would be set at elev. 70 ft or below to provide adequate submergence below the minimum expected wetwell water surface. The motor drives would be located on the operating floor. The pumps would discharge into individual vertical riser pipes that would manifold into a single conduit. Each riser would contain a loop seal with an invert at approximately elev. 165 ft, thus providing an adequate margin against backflow from the treatment works. If a pump is shut down or fails, the vacuum would be broken at the top of the loop seal by the automatic opening of an air inlet valve. This would ensure that backflow through the down pump does not exceed the volume contained in the riser pipe. The loop seal with air-inlet valve was chosen over a valve in the discharge line because of the loop seal's simplicity.

A venturi-type flow element would be provided in each discharge riser, located high on the riser so that flow into the element would be uniform. The element would be instrumented for continuous monitoring in the station's control room.

System leakage would be directed to a sump located in the pump pit floor. Two 100-percent sump pumps would maintain water level in the sump and discharge into the station wetwell. The discharge pipe would penetrate the wetwell wall above the maximum possible wetwell water elevation to prevent backflow.

Two sets of stairs located at opposite ends of the building and an elevator would provide access to all floors. Hatches in all floors would allow installation and removal of equipment by crane.

Two 100-percent-capacity vacuum priming pumps and a vacuum tank would prime the loop seal and maintain the siphon by continually removing air that may accumulate at the top of the loops due to air release from the water during normal operation. The pumps and the tank would be located on the operating floor.

An independently supported, 30-ton-capacity bridge crane would be provided for installation, removal, and maintenance handling of the major equipment. It would be sized to lift a complete pump motor assembly. Truck access to the building for delivery and removal of major equipment would be by a roll-up door adjacent to the pump motor bay.

All major electrical equipment, including switchgear, motors, the control room, and the battery room, would be located on the operating floor above flood level.

To effectively handle the wide range of possible inflows from Nut Island, all South System station pumps would be coupled to variable-speed electric drives. Two alternatives were considered to provide the required speed range: eddy-current couplings and variable-frequency drives.

Both devices would work in conjunction with a standard constant-speed electric motor to drive the pump. The eddy-current coupling would be installed between the pump and the motor and would be similar in appearance to the motor. It would be, in effect, a magnetic slip coupling. There would be no direct physical contact between the motor (or drive) side and the pump (or load) side of the coupling. With an eddy-current drive, the pump motor would operate at its

normal constant speed, and adjustment in pump speed would be achieved by increasing or decreasing the slippage at the coupling. The effect the coupling would have on the efficiency of the motor would be equal to the speed ratio, as shown in Figure 7.2.2-3. The speed controller, which is a direct current power supply, and the motor starter for each pump are located in a cabinet adjacent to the motor. The system is air cooled.

A variable-frequency drive would vary the speed of the pump motor. The motor would be directly connected to the pump, and the speed would be adjusted by varying the frequency of the power input. All components of each drive would be located in a single housing. Although a single drive is capable of controlling more than one motor, this plan would include a drive for each motor, so that the redundancy provided by the 6 pumps would be maintained. The drives would be located at the operating floor above flood level. The drives would be water cooled, and each would have an air-water heat exchanger located outside, adjacent to the wetwell side of the pump station. The effect that the drive has on the efficiency of the motor is shown in Figure 7.2.2-3.

7.3 TECHNICAL EVALUATION OF ALTERNATIVES

As discussed in Section 4.3, Criteria for Evaluation of inter-island Transport System Alternatives, the technical evaluation criteria include area, reliability, flexibility, constructibility, and quantity and quality of spoils. Reliability and flexibility apply only to the South System pumping station.

7.3.1 CONDUITS

The technical evaluation of the conduit alternatives is presented below and summarized in Table 7.3.1-1 at the end of this section.

Area

All three alternatives -- tunnel, pipeline/tunnel, and sunken tube/tunnel -- require negligible area requirements for operation.

For the tunnel alternative, no area would be required for operation. The vertical shaft on Nut Island would connect to the new headworks, and the vertical shaft on Deer Island would connect to the South System pumping station. The entire conduit would be below grade.

For the pipeline/tunnel alternative, a vent house would be required on Long Island directly over the vertical shaft. This structure, which will be a concrete building approximately 20 ft in diameter and 10 ft high, would be required to house air-emissions/odor control equipment at this system high point. The only area requirements would be for the building itself. An existing gravel roadway would be used for maintenance.

The sunken tube/tunnel alternative is identical to the pipeline/tunnel.

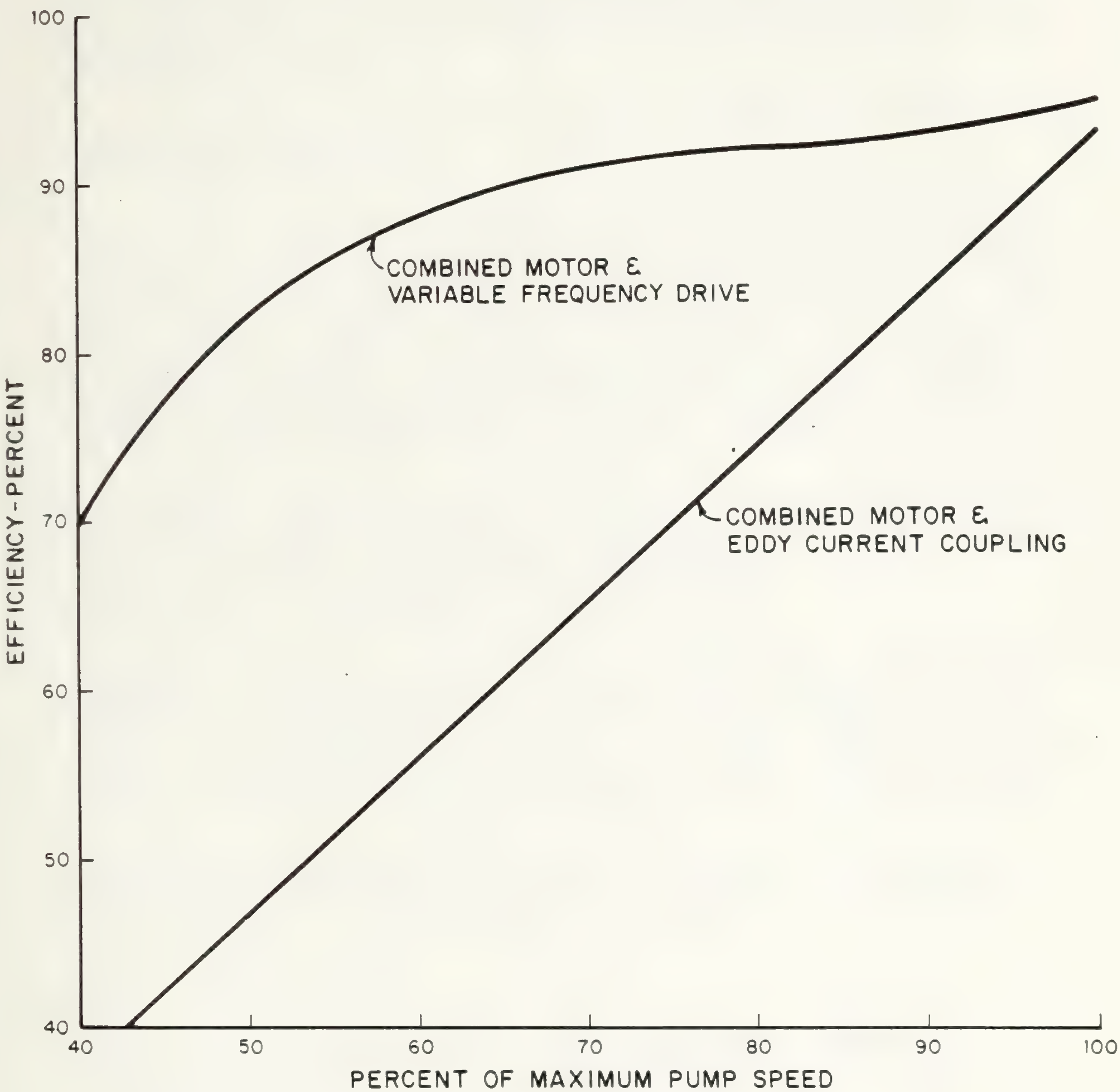


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FIGURE 7.2.2-3
VARIABLE SPEED DRIVE EFFICIENCY

Constructibility

All three alternatives -- tunnel, pipeline/tunnel, and sunken tube/tunnel -- are constructible. No new or unusual construction techniques would be required for any of the alternatives. Tunnels and subaqueous pipelines are currently used by MWRA for wastewater applications. The sunken tube concept has been used at a number of sites for transportation tunnels. In transportation applications, the longest sunken tube constructed to date has been 4 miles long in depths of water up to 130 ft.

Each of the three inter-island conduit alternatives could be constructed by the court-mandated completion date of December 1994.

The construction schedule for the tunnel alternative is estimated to be 36 months, as shown in Figure 7.3.1-1. The construction schedule is highly dependent on the advance rate of the TBM, which depends on the character of the rock. The schedule and cost estimates have been prepared based on medium-hard Cambridge argillite. An advance rate of approximately 70 ft per 24-hour workday and a work schedule of 3 shifts per day, 6 days per week, was used to develop the schedule and cost estimates. An extensive boring program to determine rock characteristics would be conducted during detailed design of the tunnels and the schedule adjusted accordingly. Tunnel construction is unaffected by weather, and construction can proceed year-round.

The construction schedule for the pipeline/tunnel alternative would also be 36 months, as shown in Figure 7.3.1-2. This schedule is based on working 3 shifts per day, 6 days per week, and laying pipe in 1 direction. The pipeline portion of the construction would be subject to weather delays. Four months have been allowed for these delays.

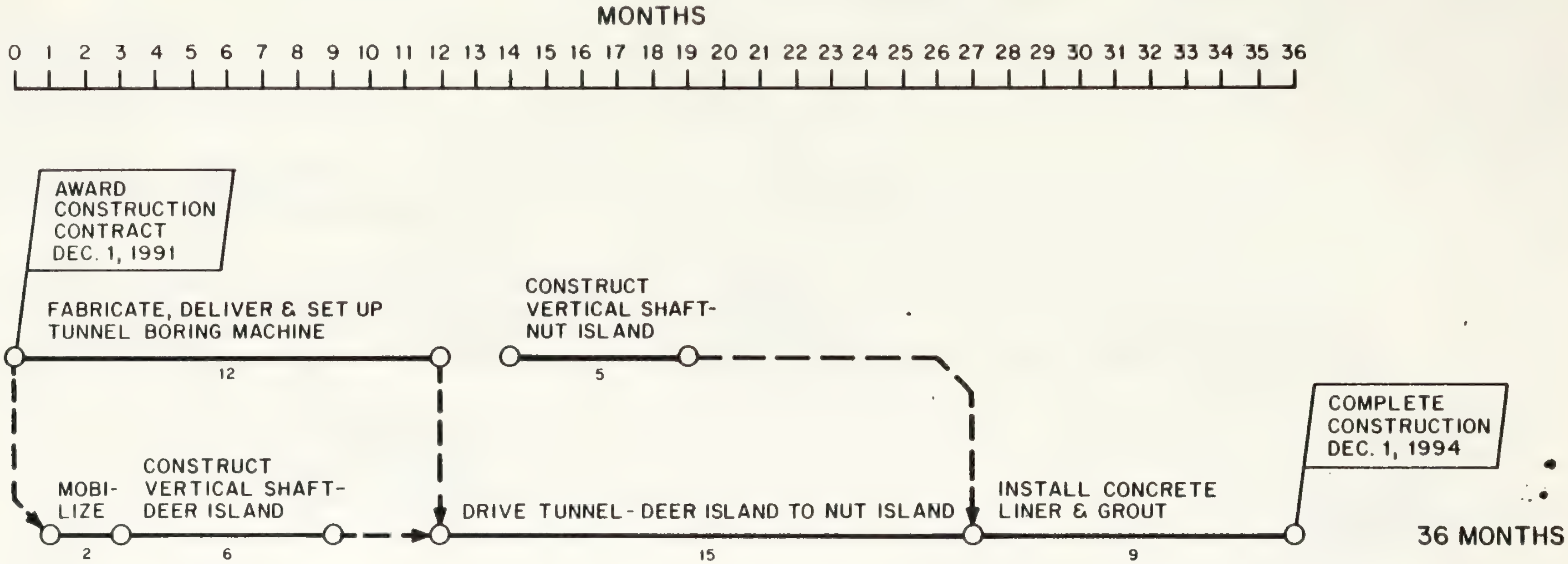
The construction schedule for the sunken tube/tunnel alternative would be 42 months, as shown in Figure 7.3.1-3. This tube laying schedule is based on working 2 shifts per day, 6 days per week, and laying tubes starting at both Nut Island and Long Island and finishing in the middle. Tunnel construction would proceed 3 shifts per day, 6 days per week. Again, due to the nature of marine construction in the Boston area, four months have been allowed for weather delays.

The construction schedule presented for each alternative is the best estimate of the actual schedule based on information currently available. Also, a minimum of 2 years should be allowed for engineering and design prior to start of construction.

Quantity and Quality of Spoils

Tunnel. For the tunnel alternative, there are three sources of spoils: the vertical shaft on Nut Island, the vertical shaft on Deer Island, and the inter-island tunnel. The total volume of excavated material for this alternative would be approximately 200,000 cubic yards.

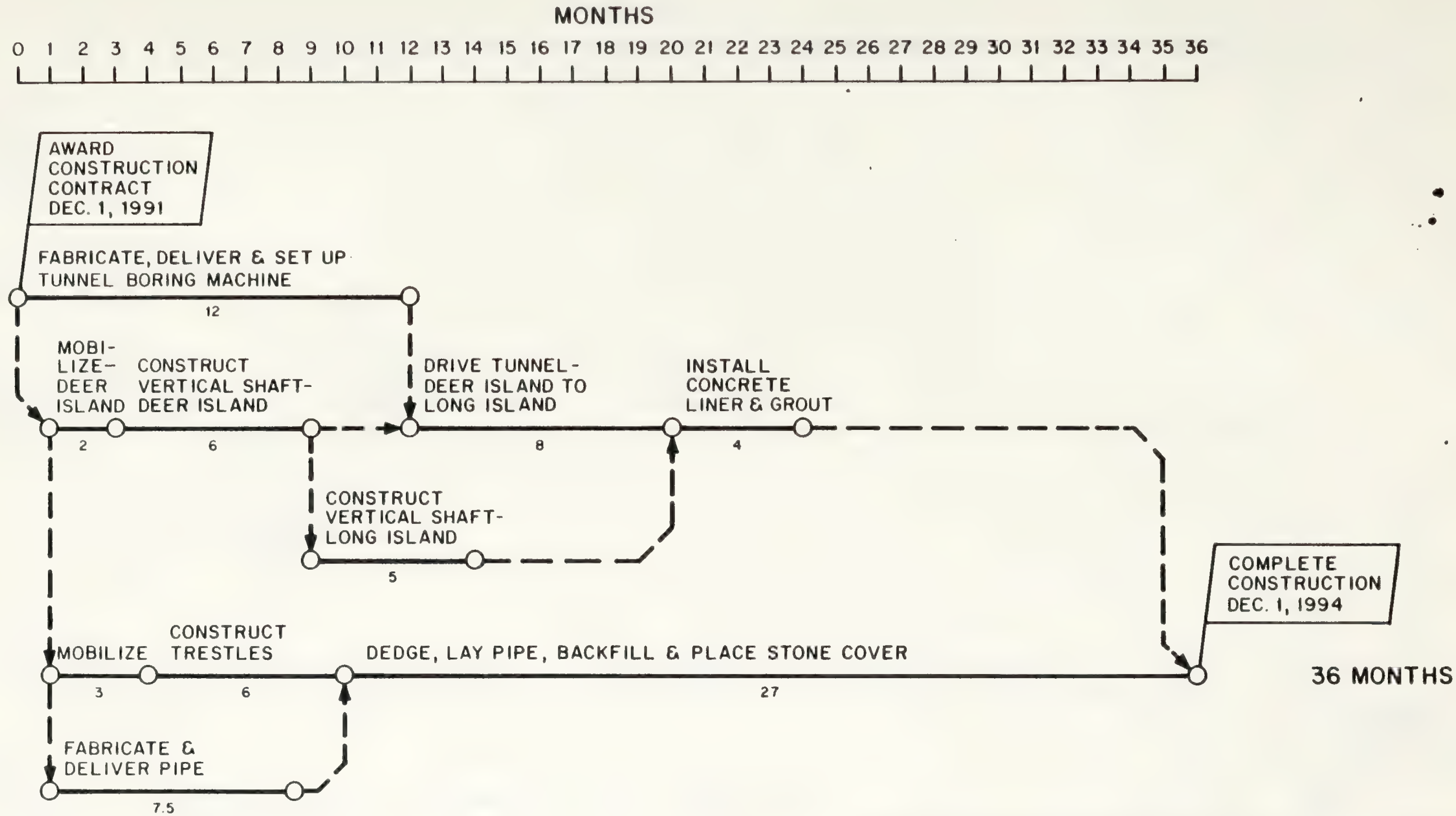
Excavation of the Nut Island shaft would result in approximately 3,000 yd^3 of spoils, of which 1,000 yd^3 would be soil (glacial till) and 2,000 yd^3 would be rock. This material, of suitable quality for use as backfill and riprap, would be used on Nut Island.



NOTES:

1. SCHEDULE REPRESENTS BEST ESTIMATE BASED ON PRESENT INFORMATION. THERE IS NO SLACK TIME OR CONTINGENCY INCLUDED.
2. ALLOW MINIMUM OF 24 MONTHS FOR DETAILED DESIGN, INCLUDING GEOTECHNICAL FIELD PROGRAM, PRIOR TO START OF CONSTRUCTION.
3. DETAILED DESIGN SHOULD BEGIN AS SOON AS TUNNEL ALIGNMENT IS APPROVED.

MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 7.3.1-1 TUNNEL CONSTRUCTION SCHEDULE



NOTE:

1. ALLOW <u>MINIMUM</u> OF 24 MONTHS FOR DETAILED DESIGN, INCLUDING GEOTECHNICAL FIELD PROGRAM, PRIOR TO START OF CONSTRUCTION.

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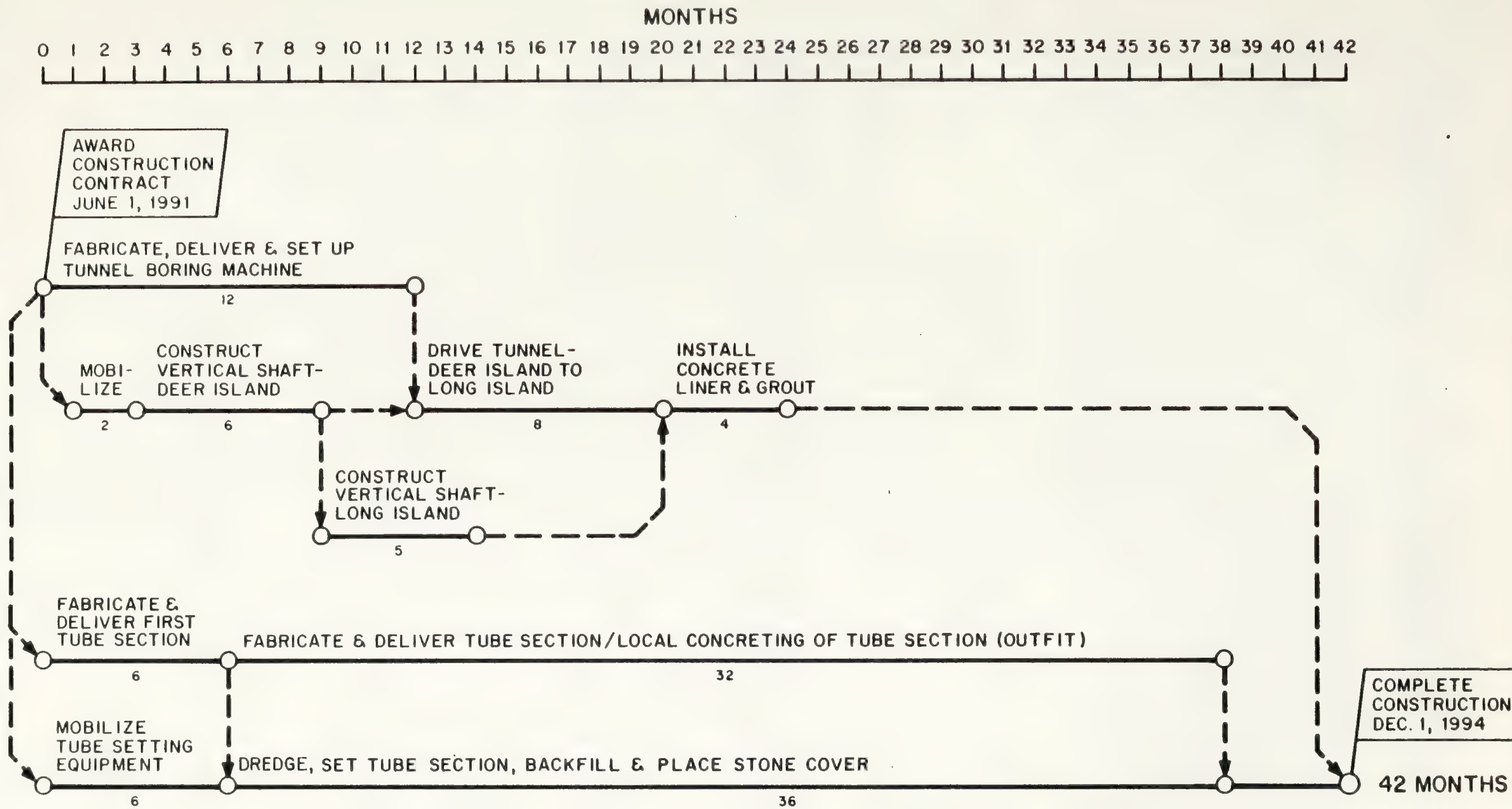
FIGURE 7.3.1-2

PIPELINE/TUNNEL CONSTRUCTION SCHEDULE



NOTE:

1. ALLOW MINIMUM OF 24 MONTHS FOR DETAILED DESIGN, INCLUDING GEOTECHNICAL FIELD PROGRAM, PRIOR TO START OF CONSTRUCTION.

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FIGURE 7.3.1-3

SUNKEN TUBE/TUNNEL CONSTRUCTION SCHEDULE

Excavation of the vertical shaft on Deer Island and the inter-island tunnel would result in another 197,000 yd^3 of spoil, of which 3,000 yd^3 would be soil and 194,000 yd^3 would be rock. This material, of suitable quality for use as backfill, would be used on Deer Island.

The bedrock to be excavated is classified as Cambridge argillite (claystone), the mineral composition of which is mainly quartz (approximately 50 percent), with nearly equal amounts of sericite (20 percent) and chlorite (20 percent) and small percentages of kaolineite and albite. The chemical composition of the argillite is mainly silicon dioxide (70 percent), aluminum oxide (15 percent), and minor amounts of several oxides such as iron, magnesium, potassium, sodium, and calcium. The size-gradation limits of the tunnel spoils generated by the TBM would range from elongated gravel-size particles to silt/clay sizes. The gradation would vary depending on actual bedrock features and operation of the TBM. The spoils would be mostly gravel-size pieces with a considerable portion of sand-size particles and some clay and silt-size particles. A size distribution is as follows:

gravel size	30-50 percent
sand size	40-50 percent
silt	10-20 percent

An evaluation is currently underway to determine the suitability of the rock spoils for use as a concrete aggregate.

Pipeline/Tunnel. For the pipeline/tunnel alternative, there are four sources of spoils: the pipeline trenching from Nut Island to Long Island, the vertical shaft on Long Island, the vertical shaft on Deer Island, and the tunnel between Long Island and Deer Island. The total volume of excavated material for this alternative would be approximately 1.6 million yd^3.

Excavation for the pipeline would result in 1.5 million yd^3 of dredged material. This material would be unsuitable for backfill, either on land or as backfill for the ocean pipeline, and would have to be disposed of in an environmentally suitable manner. For cost purposes, it was assumed that dredged material would be disposed of at sea at the Marblehead foul area.

Excavation of the vertical shaft on Long Island would result in approximately 2,400 yd^3 of material, of which 1,100 yd^3 would be soil and 1,300 yd^3 would be rock. This material would probably be of suitable quality for use as backfill and could be used on Long Island to improve the access road to the shaft area. Excavation of the vertical shaft on Deer Island and the tunnel would result in 94,000 yd^3 of spoil, of which 3,000 yd^3 would be soil and 91,000 yd^3 would be rock. Again, as described in the foregoing section on the tunnel alternative, this material would be suitable for construction and could be used on Deer Island.

Sunken Tube/Tunnel

The quantity and quality of spoils for the sunken tube/tunnel alternative are the same as for the pipeline/tunnel alternative, as described previously.

TABLE 7.3.1-1

TECHNICAL EVALUATION OF CONDUIT ALTERNATIVES

Technical criteria	Tunnel	Conduit Alternative Pipeline/tunnel	Sunken tube/tunnel
Area requirement (sq ft)	0	314	314
Constructibility	Modest	Modest	Modest
Quantity and quality of spoils (cu yd)	200,000	1,600,000	1,600,000

7.3.2 SOUTH SYSTEM PUMPING STATION

The technical evaluation of the pumping station alternatives is presented below and summarized in Table 7.3.2-1 at the end of this section.

Area

Area requirements would be small and there is essentially no difference between the alternatives. The 2 alternatives evaluated, eddy-current couplings and variable-frequency drives, would require the same building plan area of 132 ft by 80 ft, or approximately 0.25 acre. For the variable-frequency drive (VFD) alternative, a concrete pad at grade and approximately 60 ft by 10 ft would be required as a foundation for the VFD coolers.

Reliability

Both alternatives offer the same high degree of reliability. Six pump units would be installed; only four would be required to operate at peak design flow. Also, two separate and independent sources of electric power would be supplied to the station, and each pumping unit, including motor, drive, and electrical breaker, would be independent of any other unit.

Flexibility

Both alternatives provide the same high degree of flexibility. All six pumps and variable-speed drives are identical, which would allow the operator to select any desired pump-sequencing logic. Also, each alternative would allow for efficient pump operation between the minimum design flow of 80 mgd and the maximum design flow of 360 mgd. This would be accomplished by the variable-speed feature and by operating anywhere from one to four pumps. (Refer to Figure 8.1.2-3 for pump and system curves.)

Constructibility

Both alternatives would require the same pumphouse, including the substructure and the

superstructure. The pumping station would be constructed by conventional techniques and pose no unusual problems. The construction schedule, estimated as 36 months, is shown in Figure 7.3.2-1. The court-mandated schedule requires that the new outfall begin accepting flows from the existing Nut Island treatment plant via the inter-island transport system in March 1995. Therefore, the pumping station must be operational by this date.

Quantity and Quality of Spoils

Again, since the pumphouse would be the same for both alternatives, the spoils would be the same. The plan area is 132 ft by 69 ft for the deep portion of the excavation, and the required bottom of the excavation is at elev. 40 ft. The quantity of spoils from this excavation would be 30,000 yd^3. This material, all soil and suitable for backfill, would be used on Deer Island.

TABLE 7.3.2-1

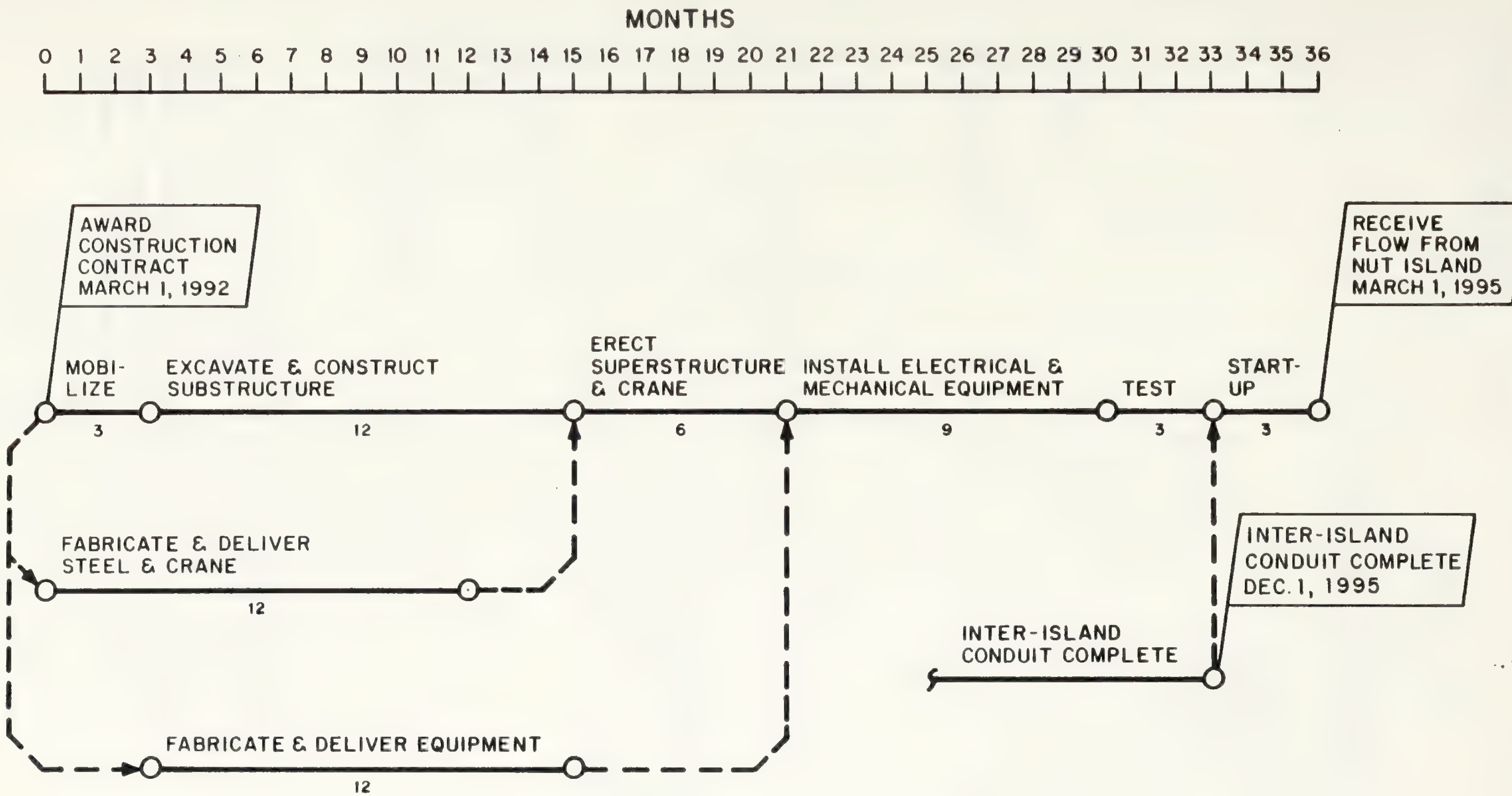
TECHNICAL EVALUATION OF
SOUTH SYSTEM PUMPING STATION ALTERNATIVES

	Variable-speed pump drives	
Criteria	Eddy-current coupling	Variable-frequency drives
Area requirements (acre)	0.25	0.25
Reliability	High	High
Flexibility	High	High
Constructibility	Modest	Modest
Quantity and quality of spoils (yd^3)	30,000	30,000

7.4 COST EVALUATION OF ALTERNATIVES

Cost estimates were prepared for each of the three conduit alternatives and each of the two pumping station alternatives. Tables 7.4-1 and 7.4-2 present the results of the cost evaluations for the conduits and the pumping stations, respectively.

As presented in those tables, present worth cost is the sum of all costs required to construct and operate the system, presented as an equivalent single initial investment. Project cost represents the estimated capital construction cost in September 1986 dollars and includes a 35-percent allowance for engineering and contingency costs. Annual operation and maintenance cost is the average annual cost to operate and maintain the system and includes the cost of



NOTE:

1. ALLOW <u>MINIMUM</u> OF 24 MONTHS FOR DETAILED DESIGN PRIOR TO START OF CONSTRUCTION.

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 7.3.2-1

SOUTH FLOW PUMPING STATION - CONSTRUCTION SCHEDULE

power. Refer to Section 4.4 for a more detailed description of the parameters used for the economic comparisons.

TABLE 7.4-1

COST EVALUATION OF
INTER-ISLAND CONDUIT ALTERNATIVES

	Cost in $ millions		
	Tunnel	Pipeline/ tunnel	Sunken tube/ tunnel
Present worth costs	63	113	172
Project costs	83	148	225
Annual operation and maintenance costs	0	0	0

TABLE 7.4-2

COST EVALUATION OF SOUTH SYSTEM PUMPING STATION ALTERNATIVES

	Cost in $ millions	
	Variable-speed pump motor drives	
	Eddy-current coupling	Variable-frequency drives
Present worth costs	38	40.6
Project costs	37.5	40.6
Annual operation and maintenance costs	1.3	1.2

7.5 ENVIRONMENTAL EVALUATION OF ALTERNATIVES

This section evaluates each of the three alternative inter-island conduit designs, using the environmental criteria described in Section 4.3. The environmental criteria categorize the potential impacts and costs for controlling impacts associated with the inter-island conduit alternatives in the following areas:

- o Air emissions control

- o Noise control
- o Environmental, including
  - Historical and archaeological resources
  - Floodplains, wetlands, and barrier beaches
  - Fish, shellfish, and other marine biota
  - Wildlife and endangered species
  - Recreational opportunities
- o Traffic

Since the alternative pumping control technologies considered for the new South System Pumping Station do not differ in terms of their potential impacts on land, air, or marine resources, the alternative variable-speed drives are not evaluated. A detailed evaluation of the impacts associated with the new pumping station is provided in Section 8.

The results of the environmental evaluation of alternatives are summarized in Table 7.5-1 at the end of this section.

7.5.1 TUNNEL

Air Emissions Control

Venting of the tunnel shafts will be required at both Deer Island and Nut Island if the tunnel alternative is selected. The unit processes selected for air emissions and odor control for the secondary treatment facility, consisting of wet scrubbing followed by activated-carbon treatment (CDM, 1987), will be used for treatment of vented air from the tunnel shafts. The need for air emissions/odor control associated with tunnel shaft venting at Deer Island and Nut Island is common to all three inter-island conduit alternatives. Since the vented air flow constitutes a minor portion (1 to 3 percent) of the dedicated air flow treatment capacity for the secondary facility, costs for treating vented air from the tunnel shafts are judged to be minor.

Noise Control

Construction of the tunnel would produce noise associated with the vertical access shafts at Deer Island and Nut Island and with the use of the nearly 200,000 yd^3 of tunnel muck for constructing landforms at Deer Island.

Construction noise associated with the tunnel alternative would not be audible at Long Island; construction noise impacts are limited to the communities adjacent to Deer Island and Nut Island. As described in Section 5.2.4, the ambient sound levels for assessing maximum nighttime and daytime noise impact in the Point Shirley area are 39 and 45 dBA, respectively, and for Nut Island, 47 dBA during the daytime.

At Point Shirley, where the nearest residence to Deer Island is located, the highest expected sound level due to the construction of the tunnel shaft is estimated to be 55 dBA, due to operation of the clamshell and cement trucks, as well as trucks transporting tunnel muck to the

landforms. Impulse sound levels resulting from silenced sheetpile-driving activities are estimated to be as high as 51 dBA. Operation of the TBM and ventilation fans would not be audible in the community.

Construction activity at the tunnel shaft on Nut Island would cause sound levels at the nearest residence, located on nearby Great Hill, to be 58 dBA due to clamshell operation and cement trucks. Peak sound levels due to silenced sheetpile-driving would be 62 dBA.

The level of effort for noise control associated with the tunnel alternative is judged to be moderate.

Environmental

Historical and Archaeological Resources. All construction activities associated with the tunnel would be on Deer Island. The vertical access shaft to the tunnel would be located approximately 500 ft to the west of the nearest historical resource, the Queen Anne farmhouse. Disposal of the total quantity of tunnel muck and materials excavated for the vertical access shaft, approximately 200,000 yd^3, would be at an area located on the perimeter of Deer Island for construction of landforms. Since construction of the tunnel would not be in close proximity to any of the historic or archaeological resources on Deer Island, no adverse effect on these resources is anticipated.

Floodplains, Wetlands, and Barrier Beaches. None of the construction activities associated with the tunnel would affect existing floodplains or wetlands on Deer Island. The only wetland identified on Deer Island is an existing effluent reservoir, located on the top of the central drumlin. The effluent reservoir would be removed as part of the early site-preparation activities described in Volume VI of the EIR/EID. There are no barrier beach resources on Deer Island.

Fish, Shellfish, and Other Marine Biota. Construction of the tunnel would have essentially no impact on the marine environment, since all surface construction activities, including disposal of tunnel muck, would be on land.

Wildlife and Endangered Species. Construction and operation of the tunnel for the inter-island wastewater transport conduit would have no impact on rare and endangered or unique wildlife species or habitat, since such resources have not been identified on Deer Island. Disposal of the approximately 200,000 yd^3 of tunnel muck on landforms being constructed on Deer Island would remove a small portion of habitat consisting of pioneer weed species and grasses. (See Figure 5.2.1-1.)

Recreational Opportunities. The location of the tunnel access shaft on Deer Island is in an area that will be developed for primary wastewater treatment facilities. Neither the location of the tunnel access shaft nor the disposal of tunnel muck on the landforms would affect existing or potential recreational opportunities on Deer Island.

Summary. Construction and operation of the tunnel would have a minimal overall effect on the existing resources considered in the environmental criteria.

Traffic

Construction of the tunnel alternative would generate additional traffic to Deer Island and Nut Island. Tunnel construction would be staged from Deer Island.

Construction of the tunnel would begin with the Deer Island vertical access shaft; equipment and crew would then move to Nut Island and construct the second vertical access shaft. Tunnel boring would begin during construction of the second shaft; tunnel lining would begin immediately after boring is complete.

It is expected that the on-island and onshore pier facilities would be complete and in operation by the time construction of the inter-island conduit begins. Construction equipment and materials would be transported to and from Deer Island and Nut Island by barge using the newly constructed piers. To identify potential transportation impacts for the inter-island conduit, it is assumed that construction workers would be transported to Deer Island through Winthrop by private automobile. Nut Island workers would travel through Quincy by automobile. Volume III of the secondary facilities planning project would examine the potential for busing workers from satellite parking facilities to Deer Island.

Traffic impacts associated with worker ferry transport and the onshore pier facilities have been addressed by others for MWRA. These studies are described in the Final Environmental Impact Reports for Onshore Water Transportation and On-Island Water Transportation Facilities. A potential onshore pier site is in Quincy. The above reports have examined construction traffic impacts on Quincy and surrounding communities. The potential traffic impacts in these communities associated with the inter-island conduit construction have not been examined and are not discussed in this report.

Material transport estimates have been developed using daily truck trips. Most material would be transported over water by barge; however, the material must first be transported over land to the mainland pier facility. It is possible that material could be trucked to the onshore piers if rail transport is not available. Communities surrounding the piers thus could be affected by construction truck traffic. In general, it has been estimated that each truck could carry 22 yd^3 or 20 tons of material.

An average of 15 to 20 workers per day would be required for construction of each vertical access shaft on the islands. The peak worker requirement is 30 to 35 workers per day. Anticipated equipment includes a crane, two trucks, a loader, a drill jumbo, a mucker, and grouting apparatus. Construction materials would include steel casing, rock bolts, concrete reinforcing bar, grout, and cement, sand, and gravel for the concrete. Approximately 3,000 yd^3 of excavated material would have to be removed from Nut Island. Excavated materials from the Deer Island shaft would be used on-island.

Tunnel boring would require 225 to 235 workers per day. There is no significant average-to-peak ratio because most of the workers would be required for the actual tunnel boring. Required equipment includes the boring machine, locomotive and muck cars for removing the excavated material, air compressors, dewatering pumps, electrical power equipment, crane, and trucks. Material requirements would include rail, ties, and ballast for the rail system; rock bolts, tie rods, steel sets, and timber for temporary tunnel support; and piping for the water and air lines and the ventilation system.

Approximately 200,000 yd^3 of material would be excavated to open the tunnel between Deer Island and Nut Island. It is expected that all the excavated material would be used on Deer Island.

Tunnel lining would require 145 to 155 workers daily. There is no significant average-to-peak ratio because most of the workers would be required for tunnel lining. Construction equipment needed would include concrete rail cars, concrete pump, and concrete forms. Material supplies would include concrete reinforcing bar, grout, and cement, sand, and gravel for the concrete. Approximately 26,000 yd^3 of concrete would be placed between Deer Island and Nut Island.

Table 7.5.1-1 summarizes the estimated number of worker trips per day to Deer Island and Nut Island and to the pipeline construction barge that could be required during conduit construction; workers associated with tunnel construction would be divided into three daily shifts. It has been estimated that approximately 1.3 persons would occupy each automobile.

TABLE 7.5.1-1
ESTIMATED AUTOMOBILE TRIPS PER DAY
GENERATED BY THE TUNNEL ALTERNATIVE

Activity	Deer Island	Nut Island
Vertical shafts	25-30	25-30
Tunnel boring	175-185	
Tunnel lining	105-115	

Table 7.5.1-2 summarizes the estimated daily truck trips that could be generated during conduit construction.

TABLE 7.5.1-2
ESTIMATED TOTAL TRUCK TRIPS PER DAY
GENERATED BY THE TUNNEL ALTERNATIVE

Activity	Trips to on-island piers
Vertical shafts	2-10
Tunnel boring	10-15
Tunnel lining	10-15

Section 7.5.1 References

Camp Dresser & McKee (CDM). 1987. Secondary Treatment Facilities Plan Detailed Evaluation of Alternatives. Massachusetts Water Resources Authority.

7.5.2 PIPELINE/TUNNEL

Air Emissions Control

Venting similar to that required by the tunnel alternative will also be required at the Deer Island and Nut Island termini for the pipeline/tunnel alternative. Air emissions/odor control for these areas of the pipeline/tunnel plan would be the same as for the tunnel alternative. However, for the pipeline/tunnel alternative, an additional air vent requiring air emissions/odor control would also be required over the vertical shaft located on Long Island. While the treatment required for the Long Island access shaft vent would be the same as that required at the termini of the inter-island conduit, a separate treatment facility would be required to control odors from the Long Island shaft vent. Costs for air emissions/odor control for the pipeline/tunnel alternative are therefore judged to be moderate, compared with the tunnel alternative.

Noise Control

Noise impacts have been evaluated for the following construction activities associated with the pipeline/tunnel alternative:

- o Construction of a vertical access shaft at Deer Island and disposal of tunnel muck on landforms on Deer Island
- o Construction of a pipeline support trestle and the pipeline in the surf zones at Long Island and at Nut Island
- o Construction of a vertical access shaft and vent house at Long Island

As described in Section 5.2.4. the ambient sound levels for assessing maximum nighttime and daytime noise impact in the Point Shirley area are 39 and 45 dBA, respectively, and for Nut Island, 47 dBA during the daytime.

The closest residential community to Nut Island is Great Hill, located at Hough's Neck. In the case of the pipeline alternative, construction of the southernmost portion of this pipeline would occur approximately 1,400 ft from the closest residence. During construction of the trestle running from the beach to the outer surf zone, pile-driving impulse noise is estimated to be as high as 71 dBA at the nearest residence, assuming the use of a standard pile driver. A silenced pile driver would be recommended for this application, which would reduce the sound level by 10 dBA to 61 dBA.

The pipeline would be laid by using three barges equipped with cranes, to dig a channel for the pipe, lay a bed for the pipe, lay the pipe, backfill, and cap the trench. The equivalent sound levels due to the use of these cranes would be as high as 42 dBA at Great Hill, gradually dropping as the pipe-laying operations moved farther away from Nut Island.

Assuming the use of a silencer for pile driving at Long Island, the pile-driving noise is estimated to have impulse levels as high as 94 dBA near the tunnel shaft and the trestle. These levels would drop to about 57 dBA near the Chronic Disease Hospital. The equivalent noise level due to the combined operation of a cement truck, a clamshell, and a backhoe would be 87 dBA. At the Chronic Disease Hospital, the noise level due to these sources would be 43 dBA. Pipeline construction noise beyond the surf zone would be as high as 66 dBA at the closest beachfront, dropping gradually as the construction moved closer to Nut Island.

At Point Shirley, the highest expected sound level due to the construction of the tunnel shaft on Deer Island would be 55 dBA due to operation of the clamshell and cement trucks, as well as trucks transporting tunnel muck to the landforms. Impulse sound levels due to silenced pile-driving activities could be as high as 51 dBA. These sound levels at Point Shirley in Winthrop would be expected to be the same for all three conduit alternatives. Operation of the TBM and the ventilation fans would not be audible in the community.

The level of effort for noise control for the pipeline/tunnel alternative is judged to be moderate, based on the use of a silenced pile driver.

Environmental

Historical and Archaeological Resources. Land areas that would be affected by construction activities associated with the pipeline/tunnel alternative include the access shaft located on Deer Island and an access shaft located on Long Island, near Bass Point, where the access shaft will connect the tunnel portion crossing President Roads to the pipeline. While significant historical and archaeological resources have been identified on Long Island, none of these resources would be in close proximity to the tunnel access shaft. Neither the location of the vertical access shaft on Deer Island nor the disposal location for the tunnel muck at the landforms on Deer Island would be near any of the historic or archaeological resources located

on Deer Island. No adverse impacts on historic and archaeological resources on either Deer Island or Long Island are anticipated.

Floodplains, Wetlands, and Barrier Beaches. None of the construction activities that would be performed on Deer Island in connection with the pipeline/tunnel alternative would affect floodplain areas or the only freshwater wetland identified on Deer Island. There are no barrier beach resources on Deer Island.

Construction of the access shaft and vent house on Long Island would involve the temporary disruption of approximately 2 acres of land located at Bass Point. Temporary beach stabilization, using steel matting, would be required to support the off-loading of construction equipment from barges. Following construction, the area would be allowed to return to its present condition, consisting of scrub growth, coarse grasses, and brush. In view of the short-term duration of the construction and the small land area required for the permanent structure, the overall impacts on the terrestrial community and affected intertidal zone are judged to be minimal.

Fish, Shellfish, and Other Marine Biota. Construction of the pipeline/tunnel alternative from Nut Island to Deer Island would result in several impacts on the marine community, primarily as the result of dredging and blasting activities associated with the pipeline.

o Dredging

Construction of the 11-ft-diameter, 14,000-ft-long concrete pipeline from Nut Island to Long Island would necessitate disruption of about 2 million square feet of benthic habitat. Dredging of the 100- to 200-ft-wide pipe trench would be accomplished with a clamshell bucket dredge. It is anticipated that approximately 1.5 million yd^3 of material would have to be dredged for the pipeline. The duration between trenching and backfilling operations is expected to be about 1 to 2 weeks. Crushed stone would be used for bedding and to backfill to the top of the pipe; armor stone would be placed on top of the pipe for protection. Backfill would not be placed over the armor stone even if the top of the stone is below the original ocean bottom. The trench would be allowed to silt in over time.

The assessment of the potential impact of construction dredging is based on considerations of the volume of material dredged, the extent of the area affected, and the type of material being dredged. Benthic organisms would be most affected by excavation of the pipe trench, since these organisms are not mobile. Organisms removed in the dredged material would be destroyed or damaged as a result of the dredging and the subsequent disposal of dredged material at the foul area designated by the U.S. Army Corps of Engineers.

No information currently available suggests that the benthic communities in the areas to be excavated are atypical of benthic communities elsewhere in Boston Harbor. In general, the benthic infauna is dominated by polychaetes, and epifaunal assemblages by hydroids, tunicates, bryozoans, and the like. The macrobenthic community within the harbor is typically composed of mollusks such as mussels, clams, and snails and crustaceans such as crabs and lobsters.

Upon completion of construction activities and after a period of stabilization, most of the pipeline habitat would again be available for benthic communities. Recolonization from surrounding areas unaffected by construction activities would be expected to occur.

o Turbidity

Turbidity associated with dredging operations can have a deleterious effect on organisms such as plankton by interfering with physiological processes. For example, turbidity can adversely affect phytoplankton by cutting down the amount of sunlight able to penetrate the photic zone. This "shading effect" can reduce primary productivity. However, the magnitude of this effect would depend on the current patterns and sediment types being dredged. Such shading will generally be short-lived, because most suspended sediments will settle out within 24 hours.

Fish, because of their mobility, can avoid the short-term ill effects of dredging and are therefore less likely to be affected by the turbidity associated with dredging. No long-term effect on local fish populations is anticipated; once excavation is complete, fish should return to the area.

o Resuspension of Toxic Materials

Dredging operations have the potential for resuspending nutrients and toxic materials (e.g., metals, PCBs, organics such as PAHs) in the water column. The results of chemical and physical analyses of sediment samples taken along the pipeline route (refer to Section 5.2.3) indicate that the dredge material may be suitable for disposal at the foul area designated by the U.S. Army Corps of Engineers (314 CMR 9.03 criteria for evaluation of dredge material). However, additional testing would be required to determine if the dredge material disposal would have acceptable effects on marine biota.

A study recently conducted (C.E. Maguire, 1987) assessed the ecological acceptability of oceanic disposal of dredged material from Nut Island and Deer Island. Solid-phase bioassay, bioaccumulation, and physical/chemical and taxonomic analyses of sediments collected from Nut Island and Deer Island were performed, as discussed below.

o Bioassay Studies

Results of the solid-phase bioassay studies conducted with grass shrimp (Palaemonetes pugio), hard-shelled clam (Mercenaria mercenaria), and sandworm (Nereis virens) indicated that, with regard to its toxicological effects, the solid phase of the dredge material from Nut Island and Deer Island would be acceptable for spoiling offshore. Mean survival of organisms exposed for 10 days to dredged material ranged from 80 to 92 percent (grass shrimp), 98 to 100 percent (hard-shelled clams), and 88 to 95 percent (sandworms).

o Bioaccumulation Studies

Results of the bioaccumulation studies conducted with grass shrimp, hard-shelled clam, and sandworm indicated that, in all cases, concentrations of mercury, cadmium, PCBs, DDT, and

aromatic hydrocarbons in organisms exposed to the solid phase of dredged material from Nut Island and Deer Island were not significantly higher than concentrations in reference organisms, suggesting that the dredged material is acceptable for spoiling.

Thus, given the above limited data, resuspension of the sediments as a result of dredging activities should not have a deleterious effect on benthic and finfish communities in the area.

o Blasting

Some underwater blasting would be required to excavate areas of the pipeline in those areas where the bedrock is at or near the surface. Underwater explosions, in general, have an adverse impact on fish (e.g., burst air bladders, concussion from pressure waves). Since minimal blasting would be required (for about 300 ft of trench length), no long-term adverse impact on fish is expected.

o Disposal of Dredged/Excavated Material

It is anticipated that approximately 1.5 million yd^3 of material would be dredged or excavated for the 14,000-ft pipeline. Options for disposal of this material include onshore spoiling on Deer Island and offshore disposal. An offshore spoil-disposal site has been tentatively identified about 20 miles out to sea, east of Deer Island in the foul area. Indications at this time are that materials dredged from the Nut Island or Deer Island areas would be suitable for offshore disposal in this area. However, further elutriate and bioassay/bioaccumulation studies are warranted to determine the ultimate environmental acceptability of this material for ocean disposal.

Wildlife and Endangered Species. There are no unique wildlife habitat areas, wildlife, or rare or endangered species resources in the areas on Deer Island that would be affected by construction proposed under the pipeline/tunnel alternative.

Also, there are no unique wildlife habitat communities or rare and endangered species located in the affected area on Bass Point on Long Island.

Recreational Opportunities. The location of the tunnel access shaft on Deer Island is in an area that will be developed for primary wastewater treatment facilities. Neither the location of the tunnel access shaft nor the disposal of tunnel muck in Deer Island landforms would affect existing or potential recreational opportunities on Deer Island.

Due to the low profile and small area requirements of the surface structure that would be located on Long Island, no visual impacts are expected to result from the facility's construction. Furthermore, the access shaft facility would not require a significant land area for a buffer zone and therefore should not affect the future prospects for recreational development on Long Island. The facility on Long Island would not require an operator and is expected to need only minimal maintenance. Consequently, once the structure is installed, further visitation or activities associated with it would be insignificant.

Summary. Construction and operation of the pipeline/tunnel is judged to have an overall significant, short-term effect on the existing resources considered for the environmental criteria. This judgment is based on the potential for adverse impacts to marine biota and water quality associated with the dredging activities required for the construction of the pipeline portion of the inter-island transport system.

Traffic

Construction planned under the pipeline/tunnel alternative would generate additional traffic to Deer Island, Long Island, and Nut Island. Tunnel construction would be staged from Deer Island; pipeline construction would be staged from a specially-equipped barge.

Construction of the tunnel would begin with the Deer Island vertical access shaft; equipment and crew would then move to Long Island and construct the second vertical access shaft. Tunnel boring would begin as soon as the tunnel boring machine was delivered and continue through construction of the second shaft; tunnel lining would begin immediately after boring is complete. Pipeline construction would occur simultaneously with the tunnel project and would require construction on Nut Island and Long Island in addition to underwater construction supported by a barge.

An average of 15 to 20 workers per day would be required for construction of each of the vertical access shafts on the islands. The peak worker requirement would be 30 to 35 workers per day. Anticipated equipment would include a crane, two trucks, a loader, a drill jumbo, a mucker, and grouting apparatus. Construction materials would include steel casing, rock bolts, concrete reinforcing bar, grout, and cement, sand, and gravel for the concrete. Approximately 2,400 yd^3 of excavated material would have to be removed from Long Island. Excavated materials from the Long Island shaft would be used on-island.

Tunnel boring would require 225 to 235 workers per day. There is no significant average-to-peak ratio because most of the workers would be required for the actual tunnel boring. Required equipment would include the boring machine, locomotive and muck cars for removing the excavated material, air compressors, dewatering pumps, electrical power equipment, crane, and trucks. Material requirements would include rail, ties, and ballast for the rail system; rock bolts, tie rods, steel sets, and timber for temporary tunnel support; and piping for the water and air lines and the ventilation system.

Approximately 94,000 yd^3 of material would be excavated to open the tunnel between Deer Island and Long Island. It is expected that all of this excavated material would be used on Deer Island.

Tunnel lining would require 145 to 155 workers daily. There is no significant average-to-peak ratio because most of the workers would be required for tunnel lining. Construction equipment needed would include concrete rail cars, concrete pump, and concrete forms. Material supplies would include concrete reinforcing bar, grout, and cement, sand, and gravel for the concrete. Approximately 21,000 yd^3 of concrete would be placed between Deer Island and Long Island.

An average of 20 to 25 workers per day would be required for construction of the pipeline conduit; the barge would be equipped with necessary construction equipment. Approximately 20 to 25 workers would be required to construct the pipeline over land on Nut Island and Long Island, for connection to the preliminary treatment facility on Nut Island and to the tunnel between Long Island and Deer Island.

Material requirements for the cut-and-cover pipeline would include 14,000 ft of 11-ft-diameter prestressed concrete pipe, and 480,000 yd^3 of gravel and stone for the dredged trench. Materials dredged from the trench would be disposed of in the foul area designated by the U. S. Army Corps of Engineers, located 22 miles east-northeast of Boston Harbor. The dredged material quantity would be 1.5 million yd^3.

Construction workers would access the barge at its dock location. The dock location could be the newly constructed onshore pier facilities or an independent mainland location. It is expected that material would be loaded onto barges at docks close to the supply source. The additional barge traffic in Boston Harbor should not impact current traffic. Table 7.5.2-1 summarizes the estimated number of worker trips per day to Deer Island, Nut Island, and Long Island and to the pipeline construction barge that would be required during conduit construction; workers associated with tunnel construction would be divided into three daily shifts. It has been estimated that approximately 1.3 persons would occupy each automobile.

Table 7.5.2-2 summarizes the estimated daily truck trips that could be generated during conduit construction. The table does not reflect truck trips that could result if it is necessary to remove tunnel excavation material off Deer Island.

Access to Long Island is currently restricted by a bridge with a 25-ton load limit. Smaller-capacity trucks might be required for moving material to and from Long Island, resulting in an increase in the truck volumes presented in Table-7.5.2-2.

TABLE 7.5.2-1

ESTIMATED AUTOMOBILE TRIPS PER DAY
GENERATED BY THE PIPELINE/TUNNEL ALTERNATIVE

Activity	Deer Island	Nut Island	Long Island	Construction barge
Vertical shafts	25-30	25-30	25-30	
Tunnel boring	175-185			
Tunnel lining	105-115			
Pipeline		20-25	20-25	15-20

TABLE 7.5.2-2

ESTIMATED TOTAL TRUCK TRIPS PER DAY
GENERATED BY THE PIPELINE/TUNNEL ALTERNATIVE

Activity	Trips to on-island piers	Trips to Long Island
Vertical shafts	2-10	1-5
Tunnel boring	10-15	
Tunnel lining	10-15	1-5
Sunken tube	1-5	1-5

Section 7.5.2 References

C.E. Maguire, 1987. Final Environmental Impact Report, Volume 2, On-Island Water Transportation Facilities for Deer Island and Nut Island. Massachusetts Water Resources Authority, March 1987 - Appendix B - Report of Sediment Sampling and Analysis.

7.5.3 SUNKEN TUBE/TUNNEL ALTERNATIVE

Air Emissions Control

Air emissions associated with the construction proposed in the sunken tube/tunnel alternative are the same as those associated with the pipeline/tunnel alternative described in Section 7.5.2. Costs associated with controlling air emissions and odors associated with shaft venting are moderate.

Noise Control

All construction activities required on Deer Island by the sunken tube/tunnel alternative are the same as those for the pipeline/tunnel alternative. Therefore, construction noise at Point Shirley in Winthrop would be the same as estimated for the previous alternative.

As described in Section 5.2.4, the ambient sound levels for assessing maximum nighttime and daytime noise impact in the Point Shirley area are 39 and 45 dBA, respectively, and for Nut Island, 47 dBA during the daytime.

Construction noise associated with the sunken tube/tunnel alternative is similar to the construction noise estimated for the pipeline/tunnel alternative, with the addition of a concrete pumping truck that would be deployed by barge over the sunken-tube route between Long Island and Nut Island. At Hough's Neck, silenced pile-driving noise could still be as high as 61 dBA. During the tube laying, the pump would cause sound levels as high as 44 dBA, which

would combine with other noise on the barges to produce a sound level of 46 dBA at Hough's Neck.

At Long Island, the addition of the concrete pump would cause sound levels as high as 68 dBA on the beachfront, which, combined with the noise from the cranes on the barges, would create a level of 70 dBA. As for the pipeline/tunnel alternative, silenced pile-driving noise would range from a peak of 94 dBA nearby to 57 dBA near the Chronic Disease Hospital. Construction of the tunnel access shaft at Long Island would cause equivalent sound levels as high as 87 dBA nearby and as high as 43 dBA near the hospital.

The level of effort for noise-control engineering for the sunken tube/tunnel alternative is judged to be moderate, in view of the use of silenced pile drivers.

Environmental

As an alternative to a pipeline between Nut Island and Long Island, a sunken tube has been considered. For this alternative, all land-based features associated with the access shafts on Deer Island and Long Island are the same as for the pipeline/tunnel alternative and have the same minimal effects relative to land-based resources.

Relative to the effects on marine biota and water quality, there is essentially no difference in the sources, type, or extent of impacts associated with the sunken-tube alternative compared to the pipeline alternative. Since longer sections of pipe would be laid in the trench, there would be some minor alterations in the schedule for opening and closing the trench, but the overall construction schedule would remain nearly the same. Thus, the evaluation of the impacts to marine biota and water quality provided for the pipeline/tunnel alternative described in Section 7.5.2 may be considered essentially equivalent in the case of the sunken tube/tunnel alternative.

Based chiefly on the potential for significant short-term impacts on marine biota and water quality resulting from dredging activities, construction and operation of the sunken tube/tunnel are judged to have an overall significant effect on the existing resources considered as part of the environmental criteria.

Traffic

Construction of the sunken tube/tunnel would generate additional traffic to Deer Island, Long Island, and Nut Island. Tunnel construction would be staged from Deer Island; tube construction would be staged from a specially-equipped barge.

Construction of the tunnel would begin with the Deer Island vertical access shaft; equipment and crew would then move to Long Island and construct the second vertical access shaft. Tunnel boring would begin during construction of the second shaft; tunnel lining would begin immediately after boring is complete. Sunken tube construction could occur simultaneously with the tunnel project.

Construction of the tunnel would begin with the Deer Island vertical access shaft; equipment and crew would then move to Long Island and construct the second vertical access shaft. Tunnel boring would begin during construction of the second shaft; tunnel lining would begin immediately after boring is complete. Sunken tube construction could occur simultaneously with the tunnel project. The steel tube would be fabricated onshore, floated to its position, and sunk to the dredged trench. Construction of the sunken tube would require construction on Nut Island and Long Island in addition to underwater construction supported by a barge.

Worker and material requirements for the tunnel portion of the sunken tube/tunnel alternative would be the same as those described for the pipeline/tunnel alternative.

An average of 35 to 40 workers per day would be required for construction of the sunken tube conduit; the barge would be equipped with necessary construction equipment. Approximately 20 to 25 workers would be required to construct the pipeline over land on Nut Island and Long Island, for connection to the preliminary treatment facility on Nut Island and to the tunnel between Long Island and Deer Island.

Material requirements for the sunken tube would include 14,300 feet of steel tube in 200-ft sections, 56,000 yd^3 of concrete for tube outfitting, and 222,000 yd^3 of stone. Materials excavated from the trench would be disposed of in the foul area designated by the U.S. Army Corps of Engineers, located 22 miles east-northeast of Boston Harbor. The excavated material quantity would be 1.5 million yd^3.

Construction workers would access the barge at its dock location. The dock location could be the newly constructed onshore pier facilities or an independent mainland location. It is expected that material would be loaded onto barges at docks close to the supply source. The additional barge traffic in Boston Harbor should not impact current traffic. Table 7.5.3-1 summarizes the estimated number of daily worker trips to Deer Island, Nut Island, and Long Island and to the sunken tube construction barge that could be required during conduit construction; workers associated with vertical shaft and tunnel lining construction would be divided into three daily shifts; tunnel boring workers would be divided into four daily shifts. It has been estimated that approximately 1.3 persons would occupy each automobile.

TABLE 7.5.3-1

ESTIMATED AUTOMOBILE TRIPS PER DAY
GENERATED BY THE SUNKEN TUBE/TUNNEL ALTERNATIVE

Activity	Deer Island	Nut Island	Long Island	Construction Barge
Vertical shafts	25-30	25-30	25-30	
Tunnel boring	175-185			
Tunnel lining	105-115			
Sunken tube		20-25	20-25	25-30

Table 7.5.3-2 summarizes the estimated daily truck trips that could be generated during conduit construction. The table does not reflect truck trips that could result if it is necessary to remove excavated material off Deer Island.

TABLE 7.5.3-2

ESTIMATED TOTAL TRUCK TRIPS PER DAY
GENERATED BY THE SUNKEN TUBE/TUNNEL ALTERATIVE

Activity	Trips to on island piers	Trips to Long Island
Vertical shafts	2-10	1-5
Tunnel boring	10-15	
Tunnel lining	10-15	
Sunken tube	1-5	1-5

Access to Long Island is currently restricted by a bridge that is limited to 25 tons. Smaller-capacity trucks might be required for moving material to and from Long Island, resulting in an increase of the truck volumes presented in Table 7.5.3-1.

TABLE 7.5-1

ENVIRONMENTAL EVALUATION OF ALTERNATIVES

Environmental criterion	Alternative		
	Tunnel	Pipeline/ tunnel	Sunken tube/ tunnel
Air emissions control	Minimal	Moderate	Moderate
Noise control	Moderate	Moderate	Moderate
Environmental	Minimal	Significant	Significant
Traffic (truck trips/day, peak)	10-15	10-20	10-20

7.6 INSTITUTIONAL EVALUATION OF ALTERNATIVES

This section evaluates the three inter-island conduit alternatives, using the criteria defined in Section 4.3. Institutional criteria include timely implementation, permitting, external coordination requirements, internal coordination requirements, demand for unique or scarce construction resources, and flexibility to meet project phasing. These criteria are not applicable to the alternative pump-drive systems considered for the South System pumping station. Therefore, the pumping station is not evaluated.

The results of the institutional evaluation of alternatives are summarized in Table 7.6-1 at the end of this section.

7.6.1 TIMELY IMPLEMENTATION

All three conduit alternatives are rated "modest" in the relative difficulty expected in maintaining the implementation schedule. The scheduled completion date of the inter-island transport conduit is December 1994. The estimated duration of construction is 36 months for the tunnel and the pipeline/tunnel and 42 months for the sunken tube/tunnel. (The schedules are shown in Figures 7.3.1-1, 7.3.1-2, and 7.3.1-3, respectively).

Tunnel construction duration would be affected by unexpected rock conditions or a breakdown of the TBM. Based on the information available, reasonable assumptions have been made for rock strength, which affects the advance rate of the TBM, and for the length of tunnel requiring

rock supports. This must be reevaluated during the detailed design phase, when a thorough geotechnical field program will be conducted along the tunnel route. To accommodate the possibility of encountering unexpected rock conditions and still meet the December 1994 completion date, it is recommended that the detailed geotechnical field program be initiated as soon as the tunnel alignment is selected. Allowing two years for the detailed design phase, of which the first six months should be set side and planned so that the geotechnical program can take place during good weather, MWRA must start detailed design no later than early 1989, preferably earlier.

The pipeline/tunnel and/or the sunken tube/tunnel construction durations could be affected by severe weather or by dredged materials containing toxic deposits that would merit special disposal requirements. Four months have been built into the schedule for weather delays. This appears to be reasonable because Quincy Bay is a relatively shallow and protected body of water.

Encountering toxic materials could result in a prolonged schedule delay; however, based on available information, this would not be likely. Therefore, 36 months to construct the pipeline/tunnel and 42 months to construct the sunken tube/tunnel are reasonable durations. For these alternatives, the tunnel portion of the conduit is not on the critical path. Therefore, unexpected rock conditions or TBM breakdowns should not affect the schedule. However, it is recommended that a geotechnical field program be initiated as soon as the conduit alignment is selected.

7.6.2 PERMITTING

The pipeline/tunnel and sunken tube/tunnel alternatives have dramatically more complex permitting requirements than the tunnel. The major factors contributing to this additional complexity are: (1) the dredging activities associated with trenching the pipeline or sunken tube would result in the removal of 1.5 million yd^3 of material that would require a disposal site; (2) the quality of the dredged material would likely vary and contain some noxious materials; and (3) potential conflicts may exist with on-water activities in Quincy Bay. These activities would require obtaining the following permits:

1. Chapter 91 Waterways License from the Massachusetts DEQE, Division of Waterways

2. Water Quality Certification Permit from the Massachusetts DEQE, Division of Waterways

3. Dredging and Disposal of Dredged Material Permit from the Massachusetts DEQE, Division of Waterways

4. Section 10 and Section 404 Permits from the U.S. Army Corps of Engineers

In contrast, the tunnel alternative would not require any unique permits because: (1) construction of the tunnel shafts would take place at least 100 ft from the wetlands and floodplain areas; (2) the tunnel construction would occur at a depth that would not interfere

with navigable waterways; and (3) the tunnel excavation would involve removing only 200,000 yd^3 of material, which would be stored on-site at Deer Island.

As a result, the permitting requirements for the tunnel are rated as "minimal." The pipeline/tunnel and the sunken tube/tunnel are rated as "extensive" in the complexity of their permitting requirements.

7.6.3 EXTERNAL COORDINATION REQUIREMENTS

All three alternatives would require "extensive" external coordination, although the relative amount of coordination varies for each alternative.

All alternatives would require close coordination with the central artery/third harbor tunnel project, since both projects have similar equipment and materials requirements.

Coordination requirements of the pipeline/tunnel and the sunken tube/tunnel plans are more complex than those of the tunnel alternative because they involve extensive coordination with the State of Massachusetts and the City of Boston regarding the use of Long Island. Potential conflicts exist between these two alternatives and current and proposed uses of the island. Currently, the island houses the Long Island Chronic Disease Hospital, a municipal facility that provides care for the chronically ill, the homeless, and the elderly. In addition, public officials are proposing to develop the island's recreational potential. The area located north of the island's Chronic Disease Hospital is slated for intensive recreational use. Passive recreational uses are proposed for the area south of the hospital, an area that contains undisturbed, environmentally sensitive natural resources.

The potential land use conflicts caused by the use of Long Island are complicated by inadequate access to the island. The present access road is a two-lane bridge built in 1951. The structural integrity of the bridge is uncertain, particularly given the need to transport materials and equipment for constructing the pipeline connection and vertical tunnel shaft.

The sunken tube/tunnel surpasses the pipeline/tunnel in its need for external coordination, since it would require a construction staging area to outfit and store the 200-ft-long sections of tube prior to installation.

In sum, the timely completion of all three alternatives would require "extensive" external coordination. However, the relative degree of coordination is somewhat less extensive for the tunnel and more extensive for the sunken tube/tunnel.

7.6.4 INTERNAL COORDINATION REQUIREMENTS

All three alternatives are rated equal in their requirements for internal coordination. All alternatives would require an "extensive" degree of coordination with other MWRA projects. Most particularly, the construction of the tunnel shaft on Nut Island would have to be planned

so as to avoid conflicts with the MWRA's ability to maintain daily operation. The operation of the facility and the movement of equipment, material, and workers for the inter-island conduit will take place in a relatively congested area, thereby generating a significant need for careful planning. In addition, the construction of all three alternatives would need to avoid conflict with the existing MWRA outfall pipeline.

Also, construction of the effluent outfall system is anticipated to be similar to the inter-island transport system in terms of schedule and construction techniques. Again, extensive internal coordination will be required to ensure availability of equipment and supplies.

7.6.5 DEMAND FOR UNIQUE OR SCARCE CONSTRUCTION RESOURCES

All three alternatives are rated as "moderate" in their demand for unique or scarce construction resources. Each alternative would require building a customized TBM, an item that would take 12 months to fabricate and deliver. The sunken tube/tunnel would require fabrication of customized tubes; however, once the initial one has been made, the remaining tubes could be manufactured at a rate of one every 3 weeks.

The availability of workers to do the tunneling is currently unknown. The local demand for tunnelers, given the construction of the proposed effluent outfall system and the third harbor tunnel, will be extremely high. However, each of the three alternatives would be affected equally if there is a high demand for workers.

7.6.6 FLEXIBILITY TO MEET PROJECT PHASING

All three alternatives are rated "fair" in the relative ease with which they could be modified to expedite the overall construction schedule. All three alternatives require that the detailed design phase begin no later than 1 December 1989 to support a completion date of December 1994. To expedite the schedule or to allow slack time, the detailed design phase should be started earlier. Since the geotechnical field work must be performed in good weather, the design phase should begin at least one year earlier.

TABLE 7.6-1

INSTITUTIONAL EVALUATION OF ALTERNATIVES

Institutional criteria	Alternative: Tunnel	Pipeline/tunnel	Sunken tube/tunnel
Timely implementation	Modest	Modest	Modest
Permitting	Minimal	Extensive	Extensive
External coordination requirements	Extensive	Extensive	Extensive
Internal coordination requirements	Extensive	Extensive	Extensive
Demand for unique resources or scarce construction	Moderate	Moderate	Moderate
Flexibility to meet project phasing	Fair	Fair	Fair

7.7 SUMMARY

Three inter-island conduit alternatives and two South System Pumping Station alternatives have been evaluated in detail. Evaluation criteria include technical, cost, environmental, and institutional considerations. The alternative conduit arrangements include a deep rock tunnel from Nut Island to Deer Island (tunnel), a pipeline from Nut Island to Long Island and a tunnel from Long Island to Deer Island (pipeline/tunnel), and a sunken tube from Nut Island to Long Island to Deer Island (sunken tube/tunnel).

The tunnel is the preferred alternative. For every criterion considered in the evaluation, the tunnel is better than or equal to the other alternatives. The major advantages of the tunnel are least environmental impact and least cost. Tunnel construction results in only 200,000 yd^3 of mostly rock spoil, which could be used as fill on Deer Island. Construction of either of the other alternatives would generate 1.6 million yd^3 of mostly unusable dredged spoils. The estimated project cost (1986 capital construction cost including engineering and contingency) of the tunnel is $83,000,000. The costs of the pipeline/tunnel and the sunken tube/tunnel are $148,000,000 and $225,000,000, respectively.

Two alternative variable-speed pump-drive systems were evaluated for the South System Pumping Station located at Deer Island. Alternative pump-drive systems do not differ from one another based on technical, environmental, and institutional considerations. Therefore, based only on their lower cost, eddy-current couplings are preferred over variable-frequency drives.

A detailed description of the recommended plan is in Section 8.0.

Section 8

8.0 RECOMMENDED PLAN

8.1 DESCRIPTION

The recommended plan for the inter-island transport system consists of a deep rock tunnel between Nut Island and Deer Island and a new pumping station located at Deer Island.

8.1.1 TUNNEL

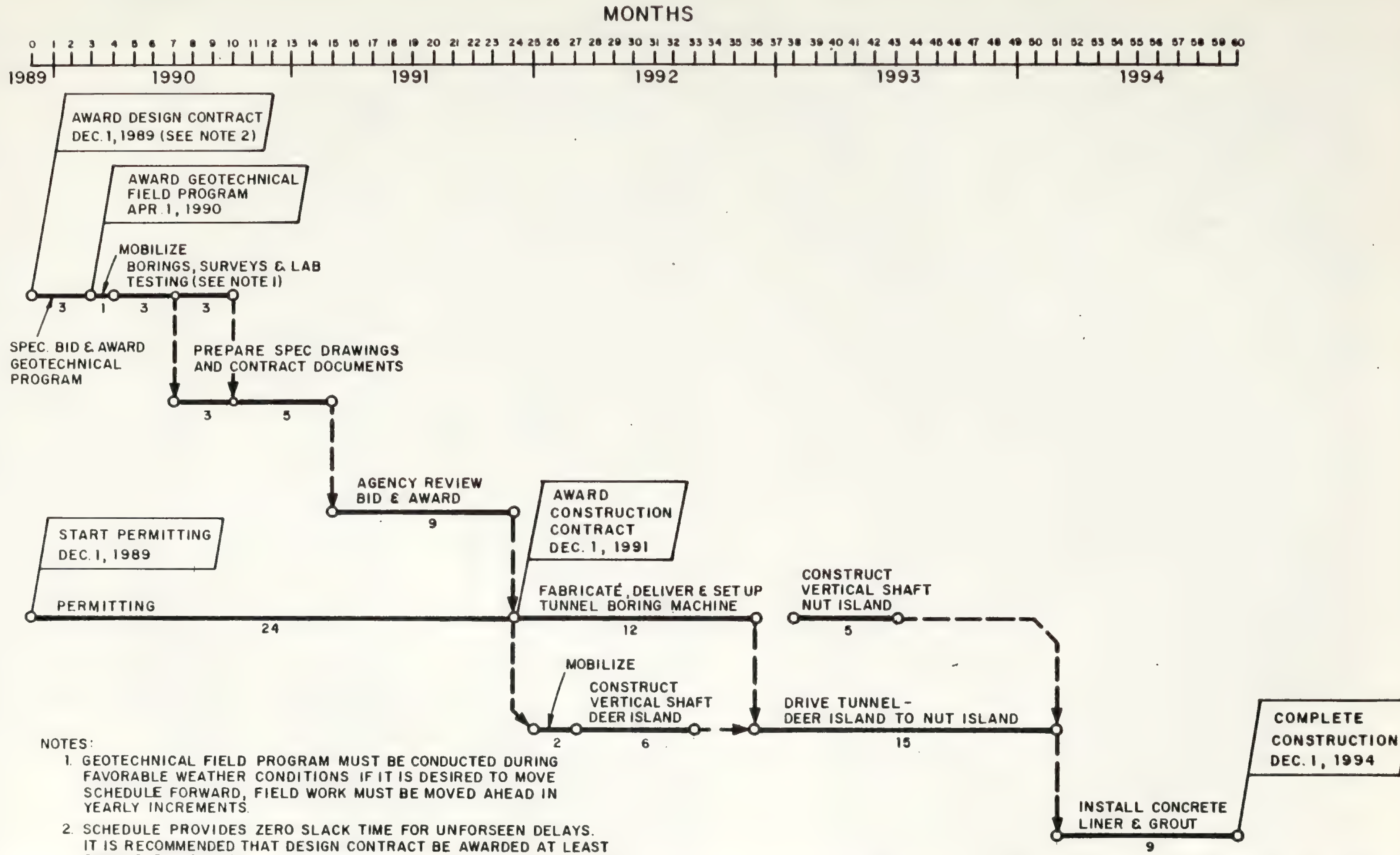
A tunnel with an 11-ft finished inside diameter will be constructed in competent rock approximately 200 ft to 300 ft below sea level. The deep rock tunnel will be connected to new headworks at Nut Island and to the new South System Pumping Station at Deer Island by vertical drop shafts. One 16-ft-diameter vertical shaft will be located at each island. All wastewater passageways will be lined with concrete. The tunnel will follow a straight line from Nut Island to Deer Island, a distance of approximately 24,800 ft. (The plan and sections of the proposed tunnel are shown in Figures 7.2.1-1 and 7.2.1-2.)

December 1994 is the court-ordered completion date for the tunnel. As shown in Figure 8.1.1-1, the Massachusetts Water Resources Authority (MWRA) must begin the detailed engineering and design work no later than December 1, 1989. Bearing in mind that this schedule provides zero slack time and that unforeseen delays during engineering or construction may occur, it is recommended that engineering begin at least one year earlier, in 1988.

The engineering and design phase consists of performing a detailed geotechnical field program, developing specifications and design drawings, and awarding a construction contract. This phase is estimated to require a minimum of 24 months to complete. The geotechnical field program, which must be conducted during good weather (April-October), will consist of on the order of 25-50 deep borings and geophysical surveys along the proposed tunnel route. Deep borings will provide information, currently unavailable, on rock strength, hardness, and bedding characteristics at the tunnel depth. Geophysical surveys will be used to provide top of rock deviations between the borings. This information is required to finalize the tunnel design, method of construction, and construction schedule.

Based on information established to date, it is anticipated that the inter-island tunnel will be mined by a tunnel boring machine (TBM) in approximately 15 months. This, however, must be confirmed. For example, discovery of significant conglomerate rock or kaolinized zones would have an adverse impact on the advance rate and economics of using a TBM. Although not anticipated, it is possible that all or some portion of the tunnel may require excavation by conventional drill and blast techniques.

Given the results of the field program, the detailed design drawings, method of construction, and construction schedule can be finalized for bidding. The tunnel contract should be awarded to a contractor no later than December 1, 1991.



NOTES:

1. GEOTECHNICAL FIELD PROGRAM MUST BE CONDUCTED DURING FAVORABLE WEATHER CONDITIONS IF IT IS DESIRED TO MOVE SCHEDULE FORWARD, FIELD WORK MUST BE MOVED AHEAD IN YEARLY INCREMENTS.
2. SCHEDULE PROVIDES ZERO SLACK TIME FOR UNFORSEEN DELAYS. IT IS RECOMMENDED THAT DESIGN CONTRACT BE AWARDED AT LEAST ONE YEAR EARLIER.

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FIGURE 8.1.1-1
INTERISLAND TUNNEL
DESIGN AND CONSTRUCTION SCHEDULE

The contractor will place the order for fabrication and delivery of the TBM. During the 12 months required to deliver the TBM, the vertical access shaft on Deer Island would be constructed. A steel headframe extending to elev 275 ft will be constructed over the shaft for hoisting. This shaft will be the access to the tunnel for personnel, equipment, and utilities. Upon delivery, the TBM will immediately begin boring the tunnel toward Nut Island. The tunnel will be driven in a straight line at a constant upward slope. The slope, which is a design requirement to help prevent deposition of solids, also facilitates drainage during construction. Based on boring through Cambridge agrillite rock with an estimated average compressive strength of 20 ksi, the tunnel boring should be completed in 15 months. All tunnel spoils will be removed through the Deer Island vertical shaft and disposed of on Deer Island. Because the TBM will operate 6 days per week, 24 hours per day, spoils must be removed from the tunnel and stockpiled on a continuous basis. However, spoils will be trucked to disposal during the first shift only. The tunnel will intersect the vertical shaft at Nut Island, and the TBM will be removed. This shaft will be constructed before the tunnel reaches Nut Island. At this point, the tunnel has been driven and supported as required along its length and is ready to accept its reinforced concrete liner. The liner can be cast in place, or sections can be fabricated at a staging area, transported to the tunnel, and installed by grouting into place. The preferred method of liner placement will be determined prior to contract award. It is estimated that the entire liner can be placed in 9 months, completing construction of the inter-island tunnel. In summary, the 36-month construction schedule includes 12 months for TBM delivery, 15 months to drive the tunnel, and 9 months to install the liner.

8.1.2 SOUTH SYSTEM PUMPING STATION

A new pumping station will be constructed at Deer Island to pump the South System wastewater to the new treatment facilities. As shown in the system flow diagram, Figure 8.1.2-1, the South System Pumping Station will receive flow from the inter-island tunnel and deliver it to the new primary treatment basins. All pumps are driven by electric motors supplied by two separate and redundant sources of electric power. To efficiently pump the wide range of design flows from 80 mgd to 360 mgd, six pumps (four operating and two spares), each with variable-speed eddy-current couplings, are recommended. The range of hydraulic gradients for the inter-island transport system and the required pump operating modes are shown in Figures 8.1.2-2 and 8.1.2-3, respectively. Plans and sections of the recommended station are shown in Figures 7.2.2-1 and 7.2.2-2 (eddy current coupling).

March 1995 is the court-ordered date for the new outfall to begin receiving flows from Nut Island. Therefore, the South System pumping station must be operational by March 1995. As shown in Figure 8.1.2-4, MWRA must begin detailed engineering and design work no later than December 1, 1989. Although attainable, this schedule provides no slack time for unforeseen delays in engineering and construction. Therefore, as with the tunnel, it is recommended that engineering begin at least one year earlier, in 1988.

The engineering and design phase consists of performing a hydraulic model study and a motor study, developing specifications and design drawings, and awarding a construction contract. This phase is estimated to require a minimum of 27 months to complete.

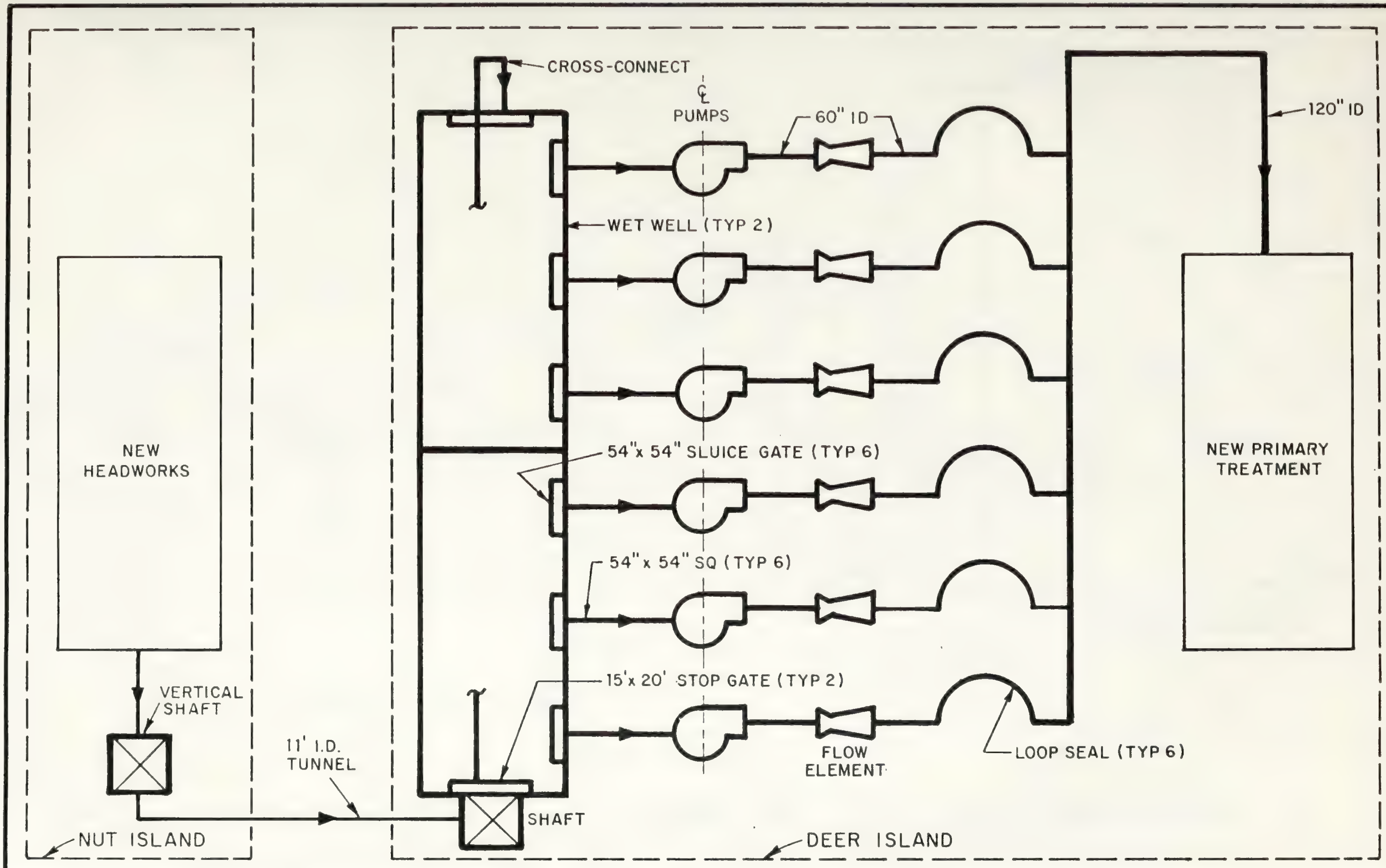

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FIGURE 8.1.2-1
FLOW DIAGRAM
INTER-ISLAND TRANSPORT SYSTEM

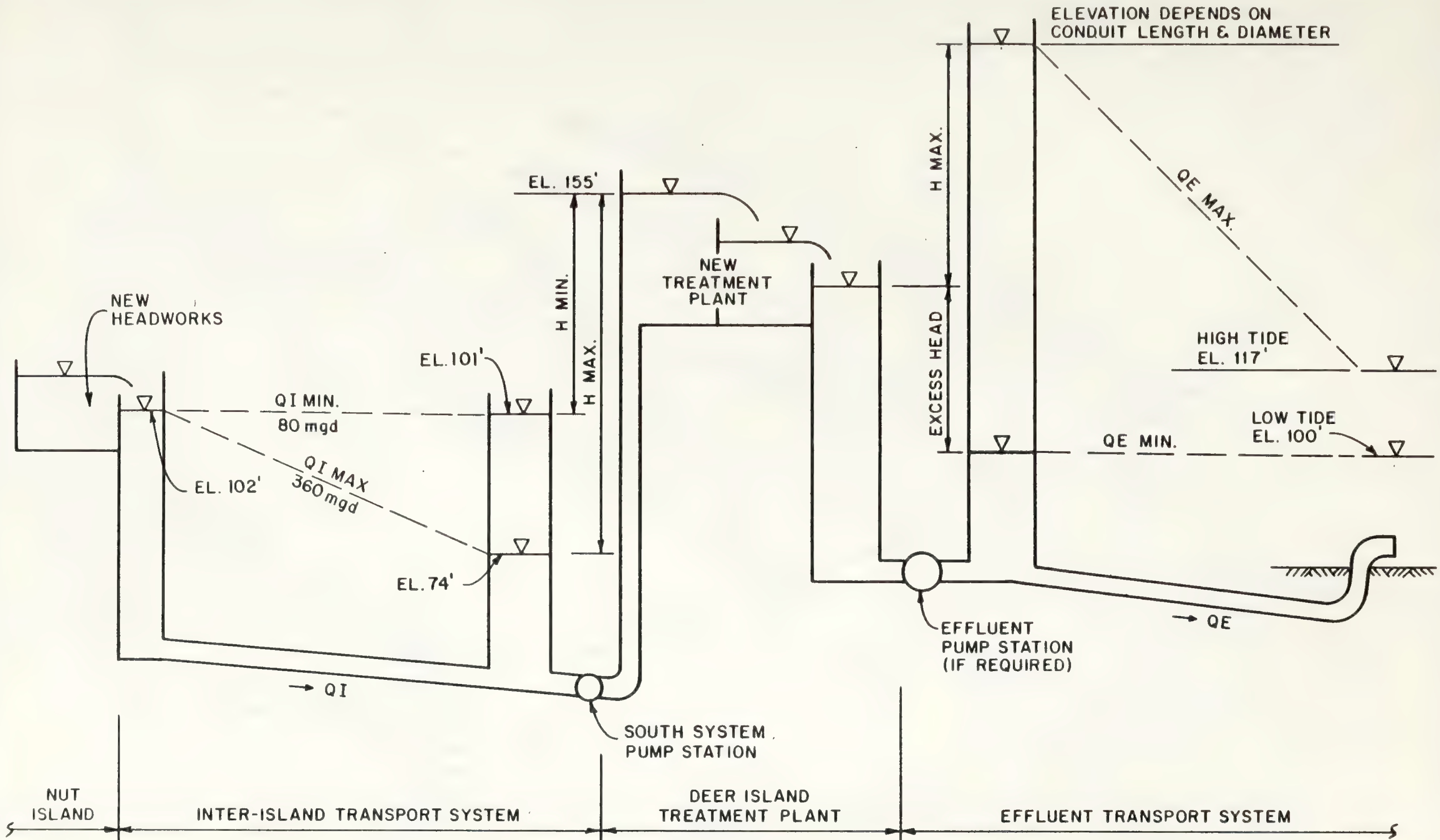

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FIGURE 8.1.2-2
PRELIMINARY RANGE OF HYDRAULIC PROFILES

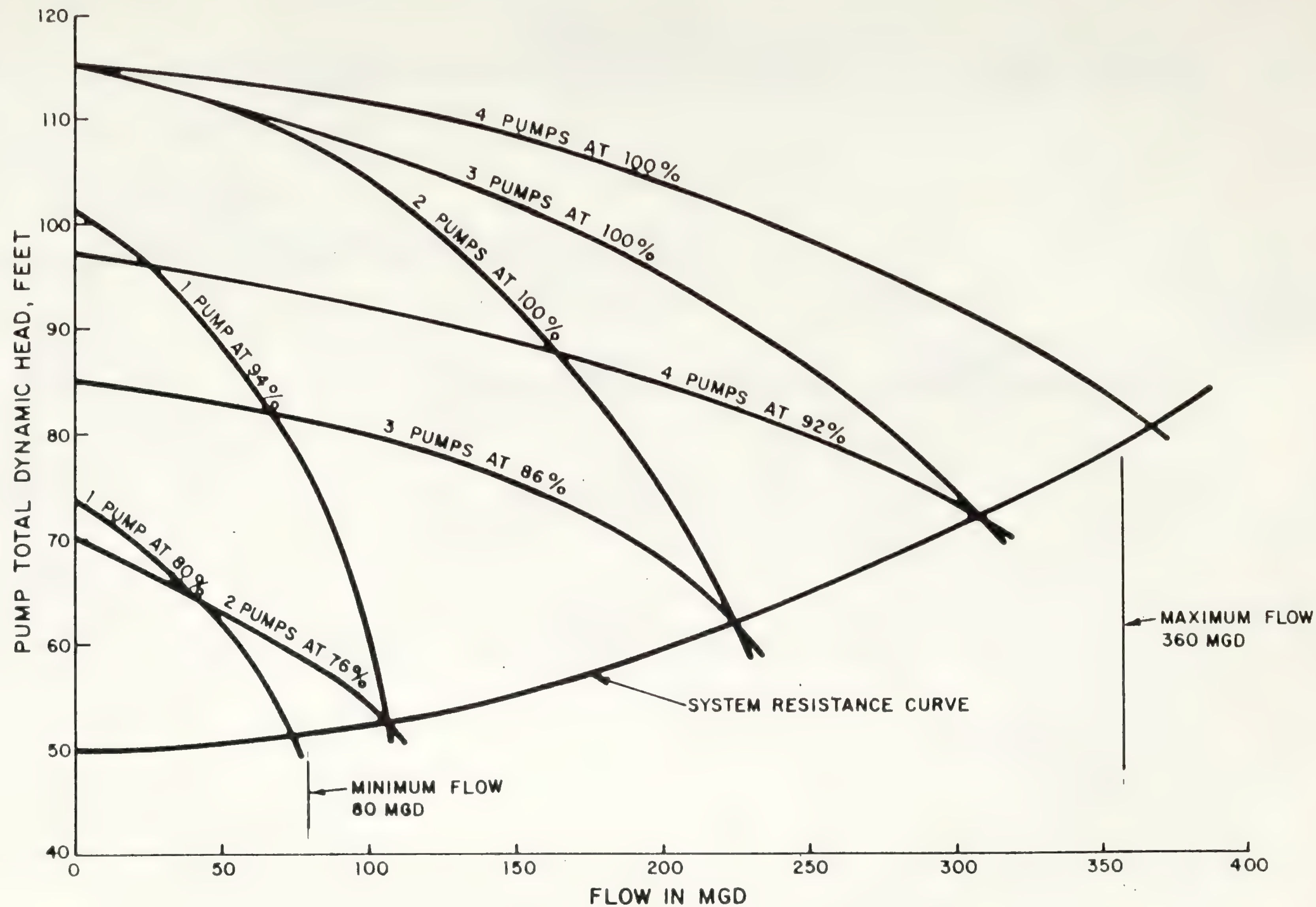

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FIGURE 8.1.2-3
PUMP OPERATING MODES
SOUTH SYSTEM PUMPING STATION

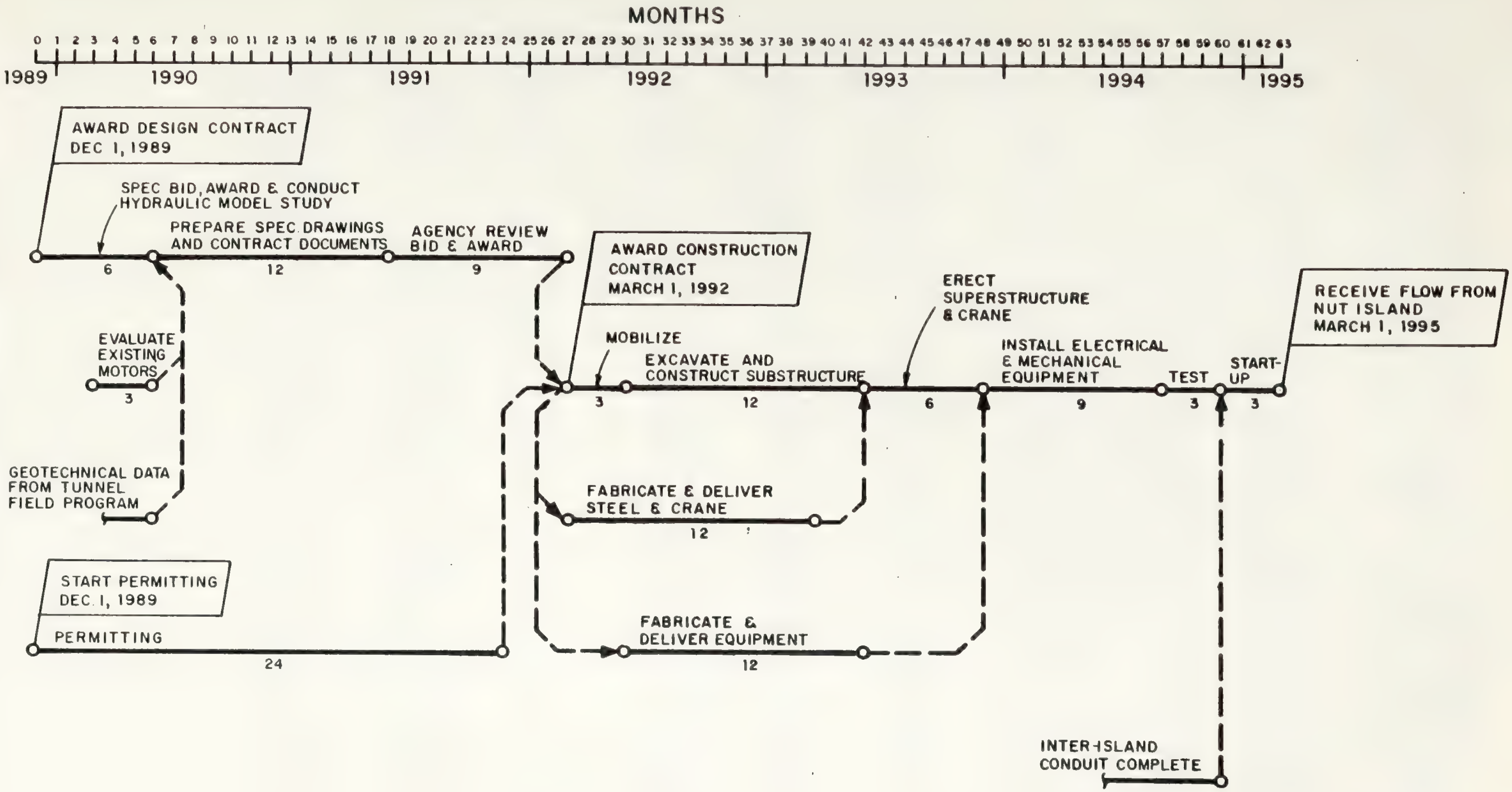

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FIGURE 8.1.2-4
SOUTH FLOW PUMPING STATION
DESIGN AND CONSTRUCTION SCHEDULE

A hydraulic model study is recommended to ensure good flow distribution to all pumps. A scale model of the pumping station would be constructed and tested. Flow patterns at maximum flow and minimum submergence would be analyzed. The model would be modified as required to provide acceptable hydraulic conditions.

A motor study will be conducted to determine if existing electric motors and drives can be used. At the completion of the Fast-Track Improvements Program in 1988, there will be five 2,000-hp electric motors and eddy-current drives installed at the main pumping station on Deer Island. It is anticipated that new motors and drives, each larger than 2,000 hp, will be required at the main pumping station as part of the new treatment facilities. However, the motors and eddy-current drives recommended for the South System Pumping Station will be rated at 2,000 hp or less, provided that no fewer than six pumps (four operating and two spares) are installed. Also, based on preliminary hydraulic analysis, four pumps are the fewest required to efficiently pump the range of design flows and resulting heads. This will be confirmed during detailed design when final pump and system curves can be developed. Therefore, it may be possible to use the Main Pumping Station motors and drives at the South System Pumping Station.

Borings directly under the pumping station will also be required as input for the foundation design. These borings could be included as part of the tunnel geotechnical field program discussed in Section 8.1.1.

At the completion of the studies and field testing, the pumping station design and specifications can be finalized for bidding. The construction contract must be awarded no later than March 1, 1991.

The contractor will place all major purchase orders for equipment and components. Construction will proceed for 36 months, in accordance with the schedule shown in Figure 8.1.2-4.

8.2 PHASED OPERATION

As discussed in Section 7.1.8, the inter-island transport system must be designed and constructed to allow phased operation.

During phase I, which must be operational by March 1995, the effluent currently being discharged at Nut Island will be discharged to the new outfall location. A schematic flow diagram and a hydraulic profile for phase I are shown in Figures 8.2-1 and 8.2-2, respectively.

During phase II, which must be operational by July 1995, the inter-island transport system will convey wastewater from the new Nut Island headworks to the new primary treatment facilities at Deer Island. The schematic flow diagram and the preliminary hydraulic profile for phase II are shown in Figures 8.2-3 and 8.2-4, respectively.

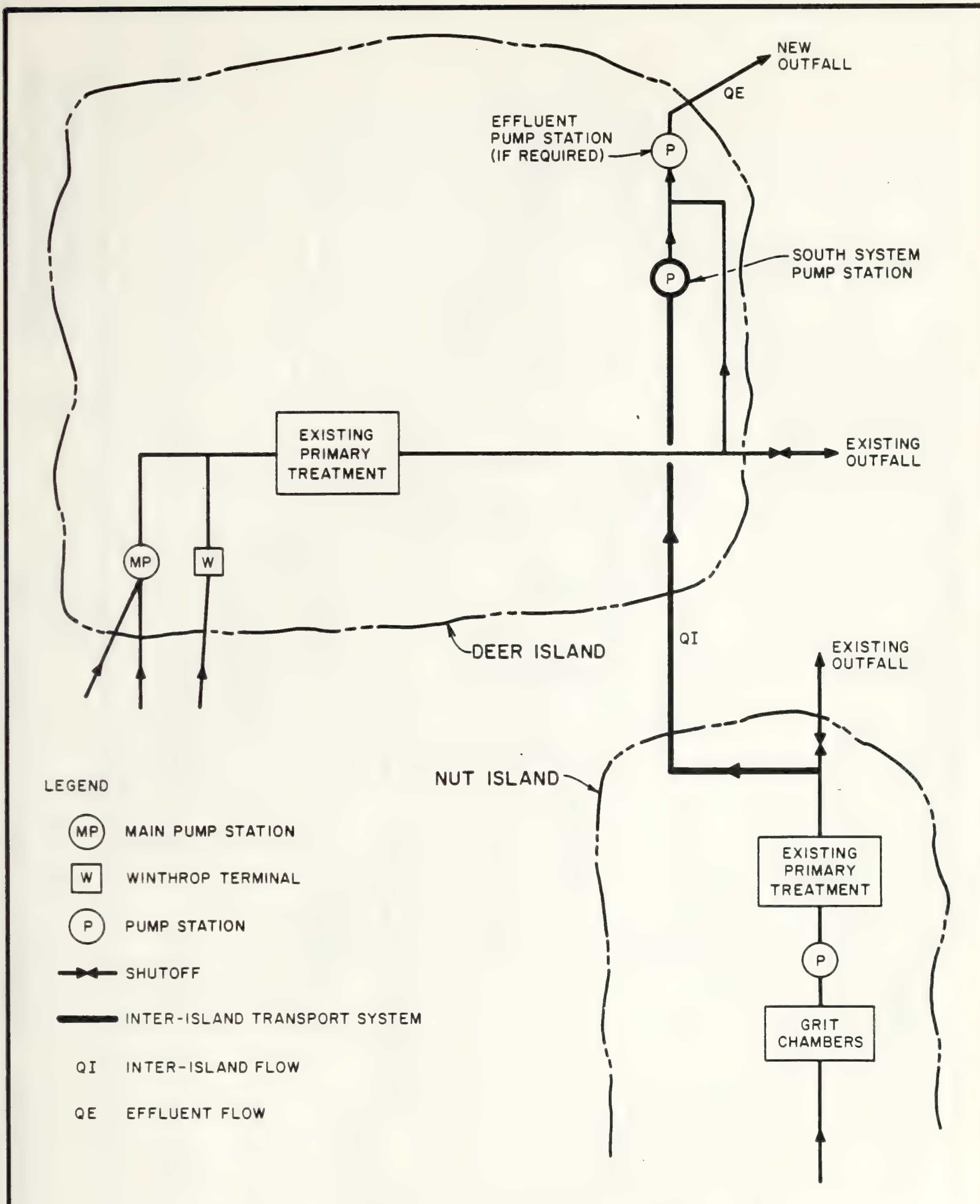

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FIGURE 8.2-1
SYSTEM SCHEMATIC
FLOW DIAGRAM - PHASE I

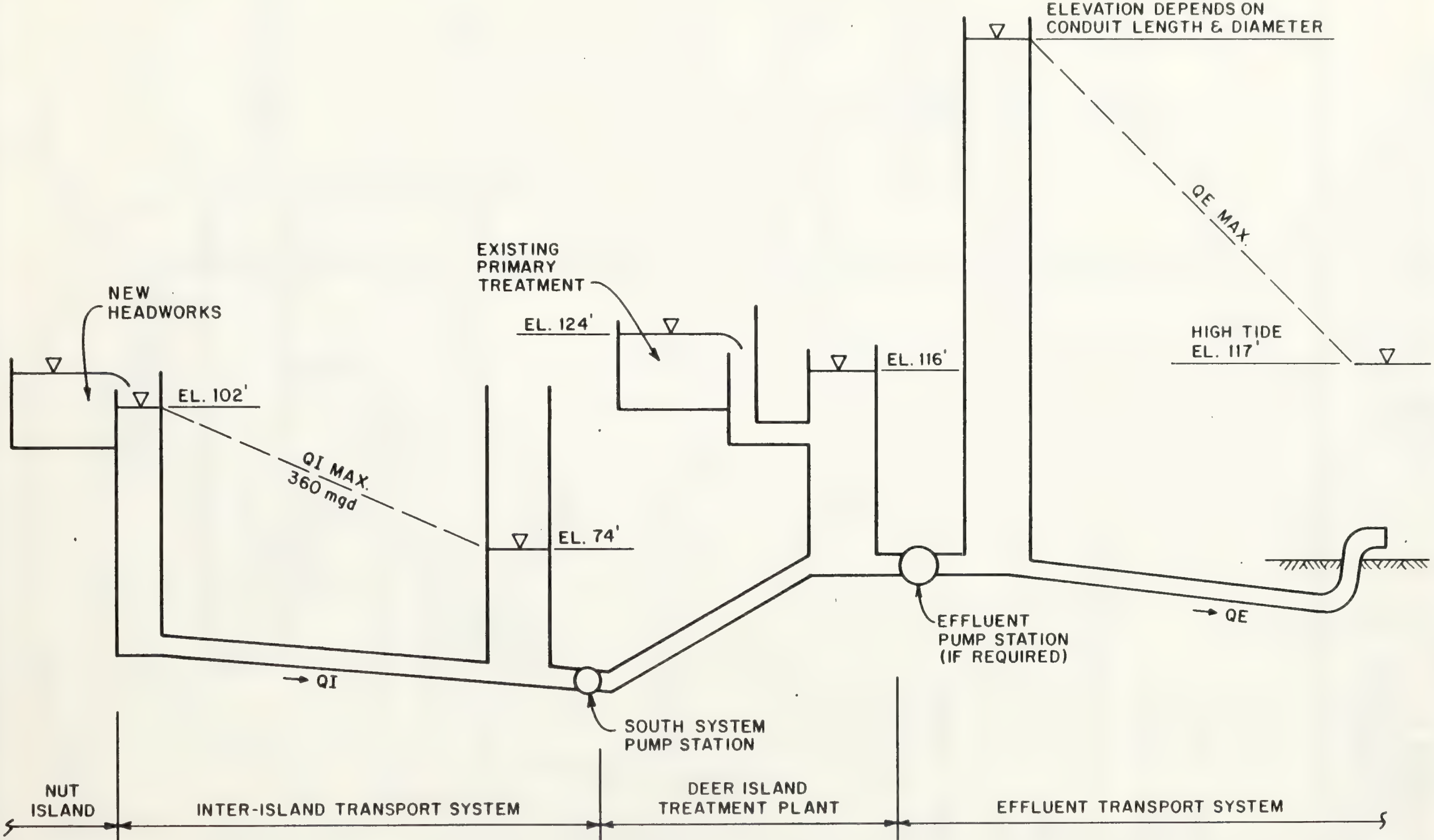

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FIGURE 8.2-2
PRELIMINARY HYDRAULIC PROFILE - PHASE I

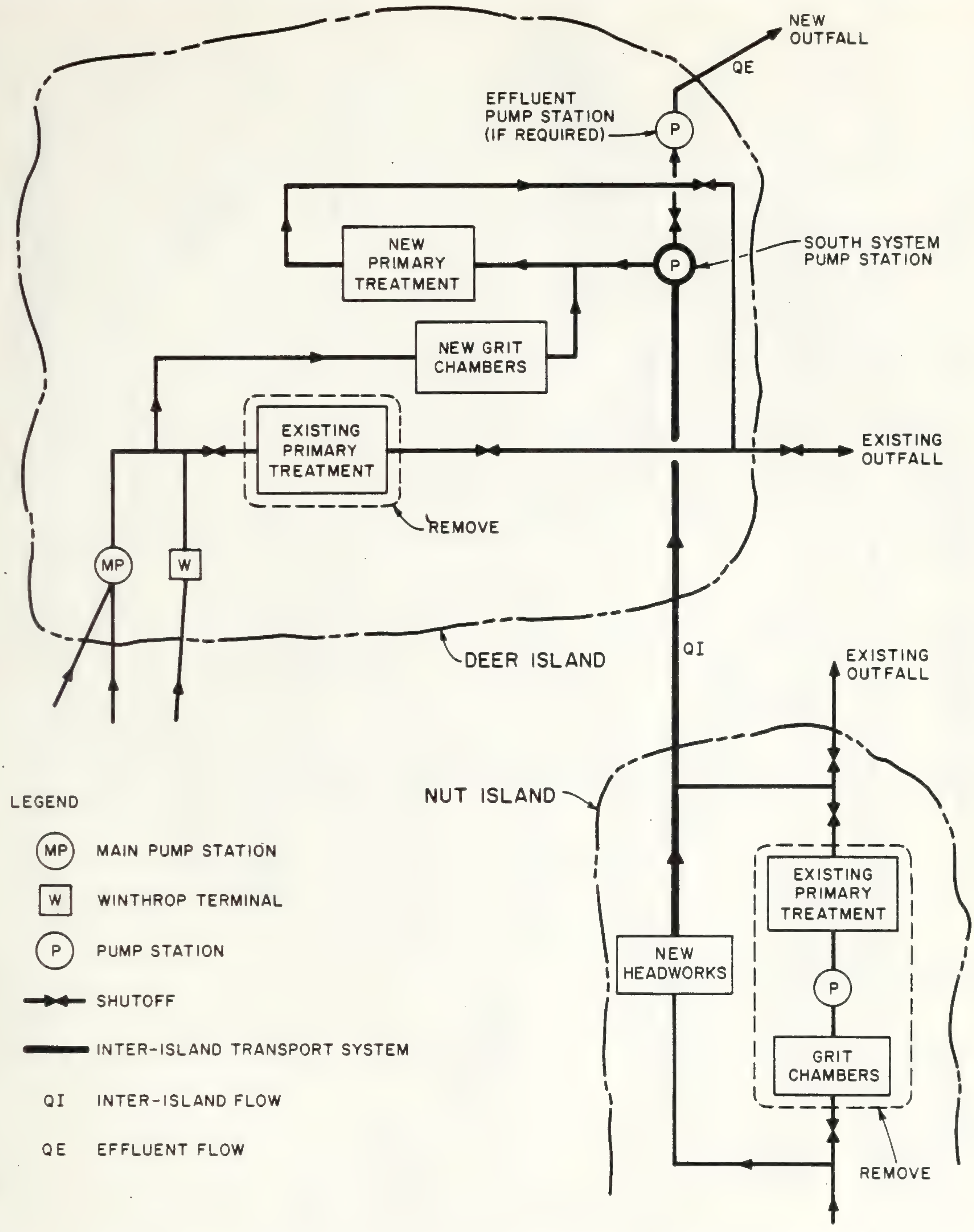

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FIGURE 8.2-3
SYSTEM SCHEMATIC
FLOW DIAGRAM - PHASE II

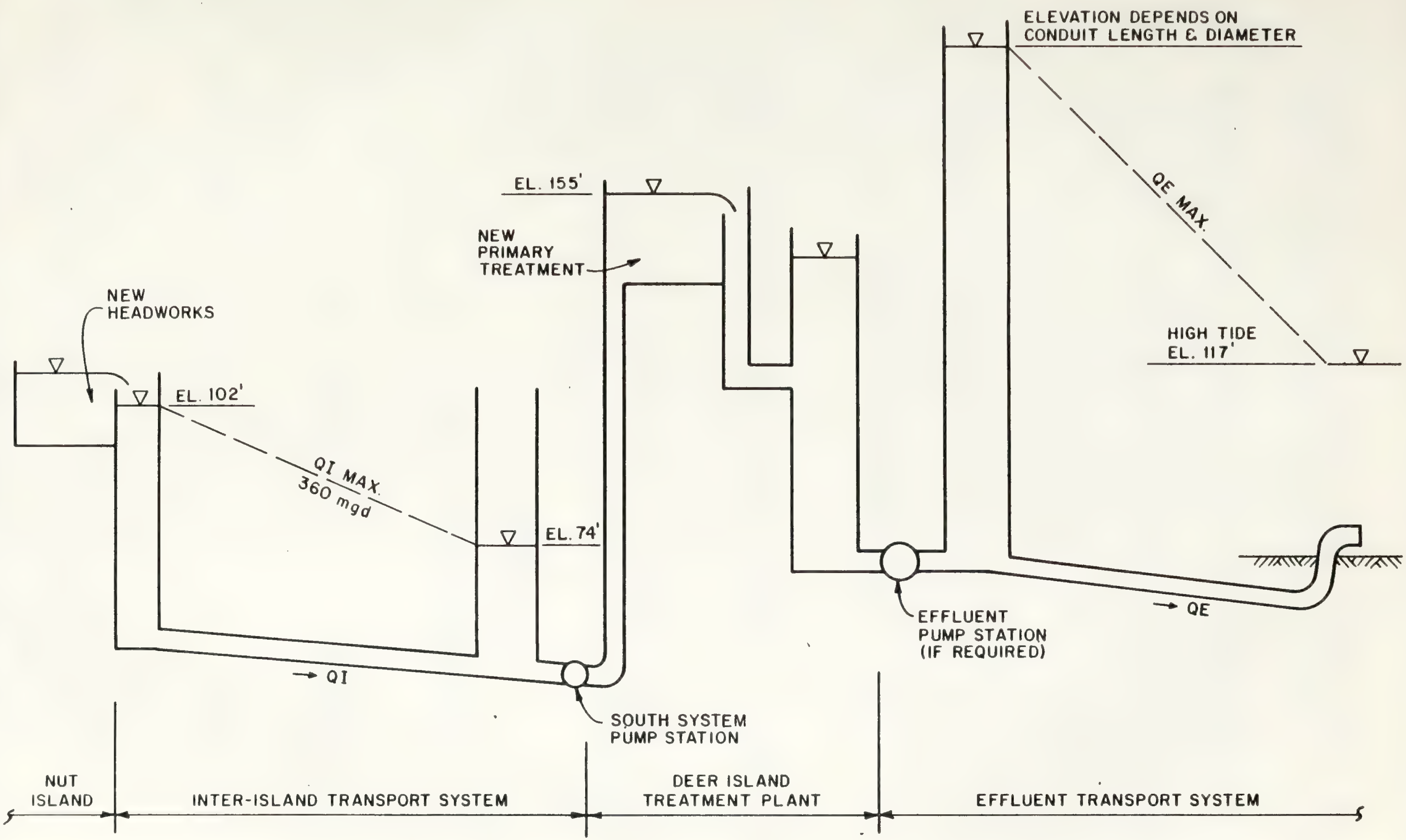

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FIGURE 8.2-4
PRELIMINARY HYDRAULIC PROFILE - PHASE II

During phase III, which must be operational by December 1999, new secondary treatment facilities will be complete. A schematic flow diagram and a hydraulic profile for phase III are shown in Figures 8.2-5 and 8.2-6, respectively.

The hydraulic conditions for the inter-island transport system during phases II and III, or beyond July 1995, are constant. Specifically, the South System Pumping Station must pump 360 mgd at a total dynamic head (TDH) of 81 ft (155 ft - 74 ft). Only during phase I are the hydraulic conditions different. During phase I, the design flow of 360 mgd is the same, but the required TDH is only 42 ft (116 ft - 74 ft). Several alternative arrangements would provide satisfactory pump operation under both hydraulic conditions: installing different impellers, operating five or six pumps at reduced speed, or temporarily adding head to the system. Each alternative has advantages and disadvantages. The preferred arrangement depends on the short length of time required in phase I operation. Based on the court-mandated schedule, phase I operation may occur only for four months, from March 1995 to July 1995. For this short duration, it is recommended that five or six pumps be operated at lower speed if the 360-mgd maximum design flow should occur. This alternative requires no change or added cost to the base scheme. The need to operate five or six pumps at 360 mgd depends on the characteristics of the pump and will be determined during detailed design.

8.3 COSTS

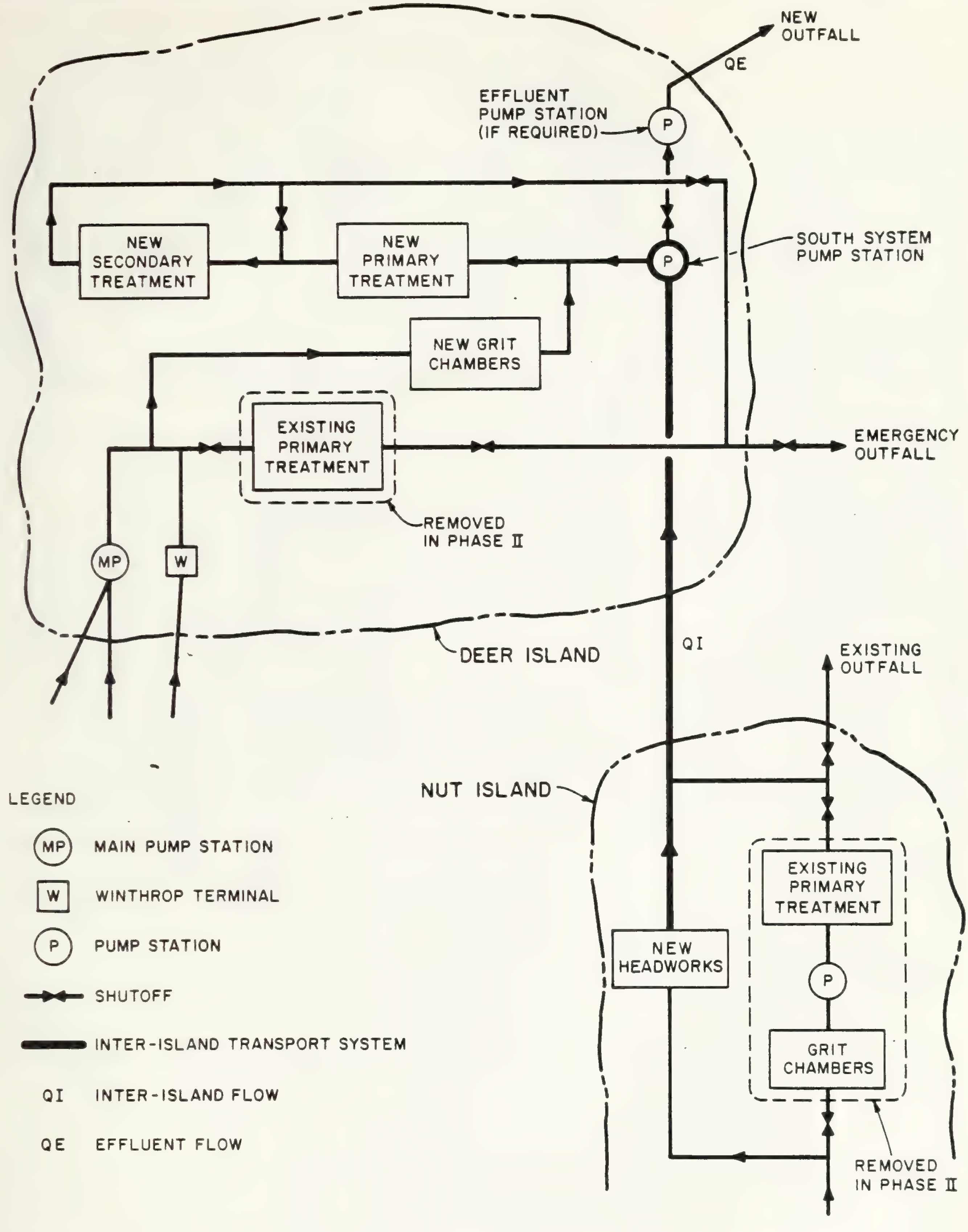
Estimated costs were developed for the inter-island transport system. This system includes the inter-island tunnel, the South flow pumping station, and vertical shafts on Nut Island and Deer Island.

As presented in Table 8.3-1, project cost represents the capital construction cost in September 1986 dollars and includes a 35 percent allowance for engineering and contingency costs. Annual operation and maintenance (O&M) cost is the average annual cost to operate and maintain the system and includes the cost of energy.

TABLE 8.3-1

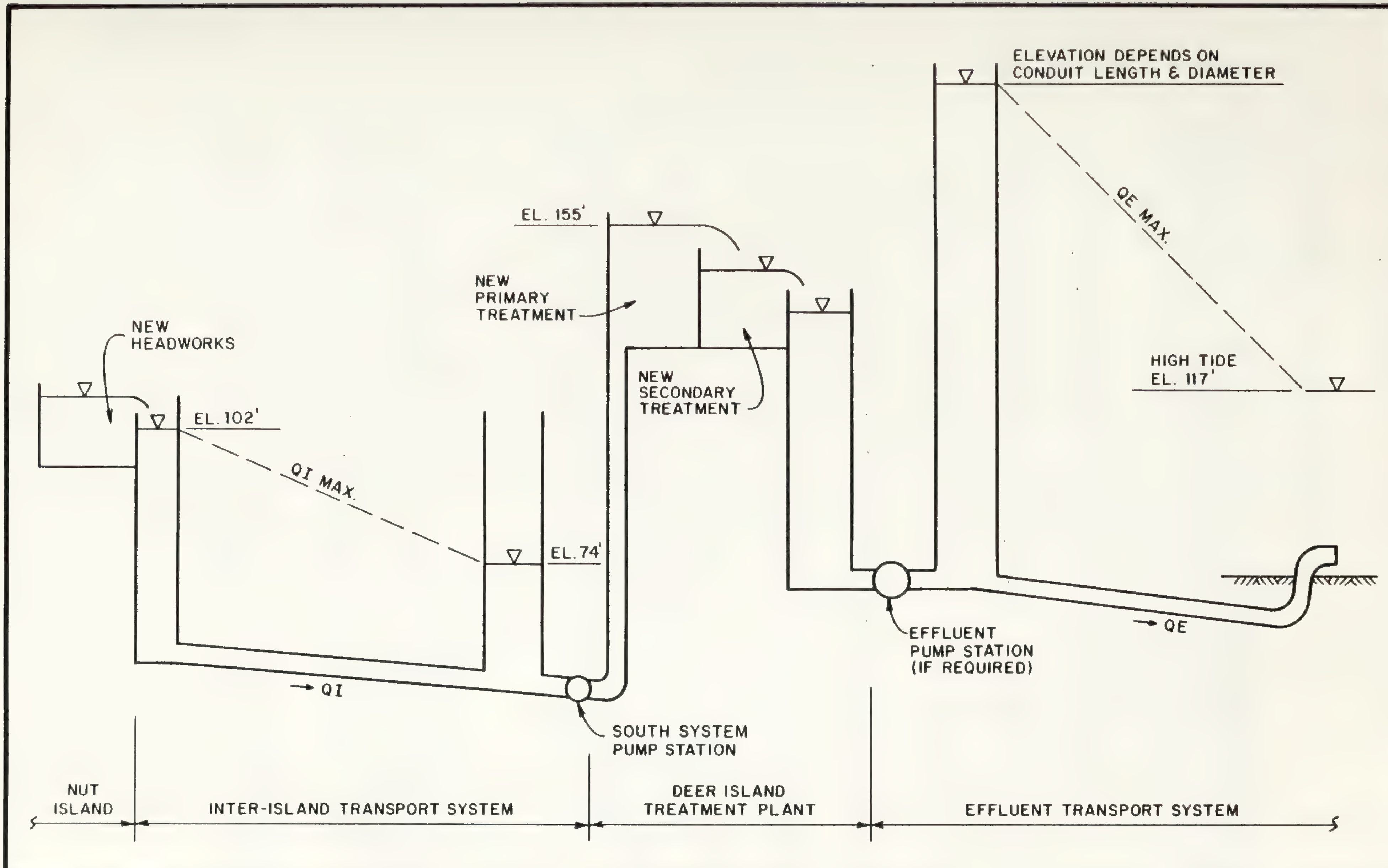
INTERISLAND TRANSPORT SYSTEM
COSTS FOR RECOMMENDED PLAN

	Tunnel	South System Pumping Station	Total
Project cost	$83,000,000	$37,500,000	$120,500,000
Annual O&M cost	0	$1,300,000	$1,300,000



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 8.2-5
SYSTEM SCHEMATIC
FLOW DIAGRAM-PHASE III



MASSACHUSETTS
WATER RESOURCES
AUTHORITY

FIGURE 8.2-6

PRELIMINARY HYDRAULIC PROFILE - PHASE III

8.4 ENVIRONMENTAL IMPACT ASSESSMENT

Section 8.1 describes the recommended plan for the inter-island wastewater transport system. Actual construction of the system conduit and South flow pumping station will begin in early 1992. The tunnel and the pumping station will be completed by December 1994 and March 1995, respectively. Major construction activities required for the inter-island wastewater transport system include the following:

- Construction of a vertical access shaft at Deer Island, including excavation of approximately 3,000 yd^3 of soil and rock

- Construction of the 5-mile-long inter-island tunnel from Deer Island to Nut Island, including removal of approximately 194,000 yd^3 of tunnel muck

- Construction of a vertical access shaft at Nut Island, including excavation of approximately 3,000 yd^3 of soil and rock

- Disposal of all tunnel muck and materials excavated from the vertical access shafts on landforms to be constructed on Deer Island, as shown in Figure 8.4.1-1

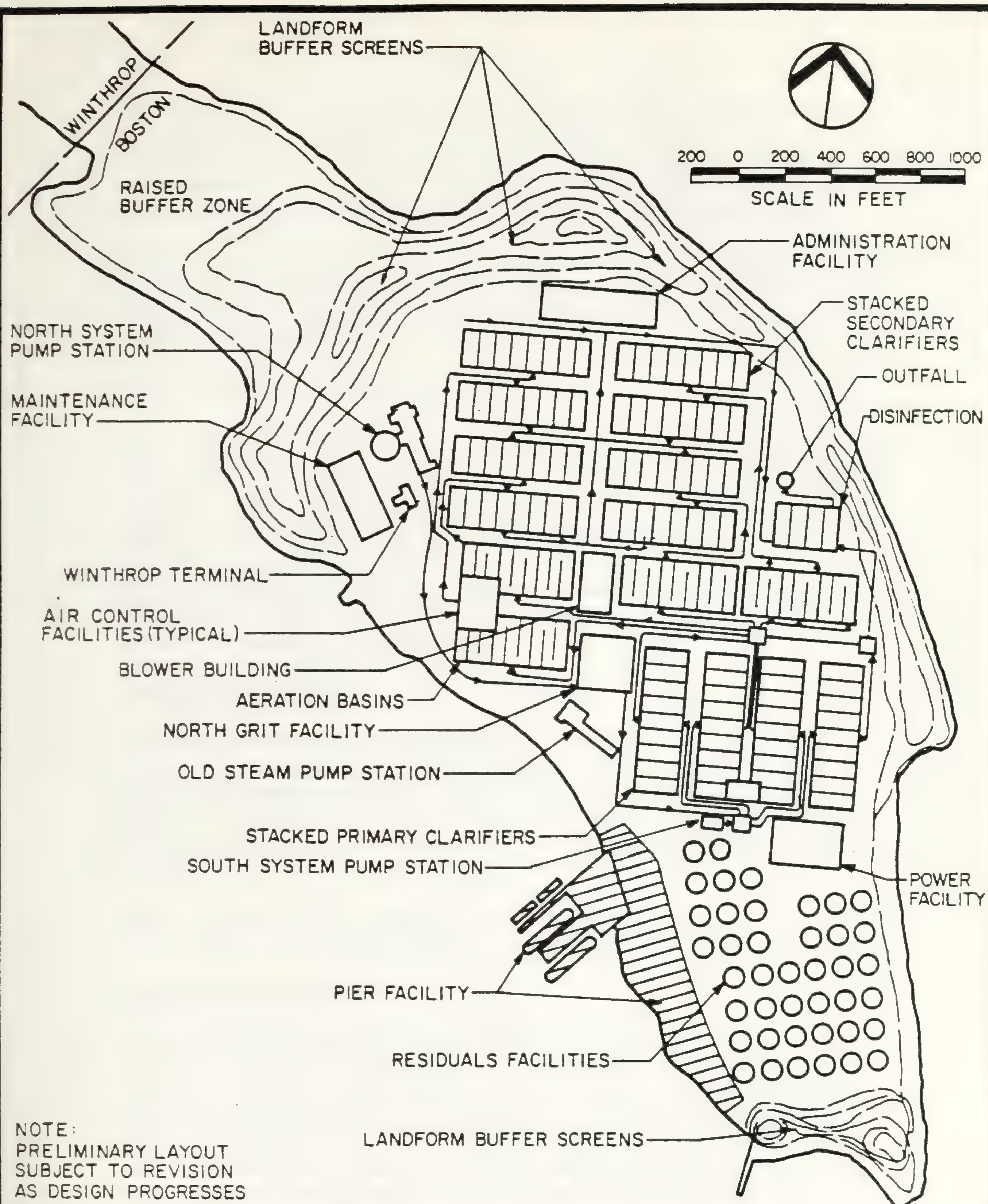
- Construction of the new, 80 ft by 130 ft by approximately 50 ft high South System pumping station on Deer Island, including approximately 30,000 yd^3 of soil excavation

The following sections provide an assessment of the construction and operation-related impacts of the inter-island wastewater transport system. Impacts directly resulting from these construction activities have been assessed independently of impacts from the construction of the new primary treatment and outfall facilities, which will occur at the same time as the construction of the inter-island transport system. Combined impacts from all ongoing construction activities will be assessed, as appropriate, in the Treatment Plant EIR/EID, Volume III, and the Outfall EIR/EID, Volume V.

8.4.1 LAND USE

The new South System pumping station will occupy only approximately 0.25 acres of land and will be located as shown in Figure 8.4.1-1. This location is in an area that will be developed for primary wastewater treatment facilities. Neither the locations of the tunnel access shaft and the South System pump station nor the use/disposal of tunnel muck and excavation spoils for landform construction in the area of the primary treatment plant (as backfill) will affect existing or potential recreational opportunities on Deer Island.

As described in Section 8.1, a headform structure will be temporarily erected at the location of the South System pumping station to support materials and equipment handling associated with the tunnel construction. The top of the headframe will be at an elevation of



MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 8.4.1-1 SITE LAYOUT SECONDARY TREATMENT FACILITIES DEER ISLAND

approximately 275 ft. As a point of reference, the elevation at the top of the central drumlin (removed during early site preparation activities, as described in Volume VI of the EIR/EID) is at an elevation of 210 ft. Notification to the Federal Aviation Administration will be filed for this structure, in accordance with the requirements of 14CFR, Chapter 1, Part 77, since it is within the proximity requirements of notification relative to Logan Airport's runway 27.

The vertical access shaft on Nut Island will be located in a building that will be an integral part of the new Nut Island headworks facility. The screenings building will be located at Nut Island. The potential impacts on land use of the screenings building will be assessed in the Treatment Plant EIR/EID, Volume III.

8.4.2 TERRESTRIAL ECOLOGY

Construction activities associated with the inter-island wastewater transport system will result in some minor incremental impacts to the local terrestrial ecosystem, considering that major earthmoving and other construction activities will already have taken place on Deer Island (refer to Section 8.3 of the Early Site Preparation EIR/EID, Volume VI). Sources of potential impact on flora and fauna associated with construction include: (1) the generation of fugitive dusts, (2) increased potential for erosion of cleared surfaces, (3) construction-generated noise, and (4) the movement of construction personnel, equipment, and materials onsite. Each of these impacts has been assessed for each of the inter-island wastewater transport system construction activities.

Generation of Fugitive Dust

Fugitive dust generated by heavy equipment and/or truck traffic during construction of the pumping station, access shaft, and tunnel on Deer Island can adversely affect vegetation in areas adjacent to construction activities. Dust particles can clog leaf stomata, thereby reducing gas exchange necessary for photosynthesis and respiration. Airborne dust particles can also reduce photosynthesis through a process known as "shading" (i.e., limiting the amount of sunlight reaching the surfaces of green plants).

Fugitive dust onsite will be controlled by the use of water spray trucks to dampen exposed surfaces. Thus, no adverse impact of dust on vegetation in adjacent communities is expected.

Increased Potential for Erosion

Surfaces that have been cleared, grubbed, and graded will be more susceptible to erosion. Because of the quantities of excavated soils and tunnel muck that must be moved during the construction of the inter-island transport system, a construction mitigation program will be necessary at the Deer Island site to control erosion and prevent sedimentation into adjacent areas, particularly tidal wetlands. The construction mitigation program will ensure that runoff from exposed surfaces will drain to settling basins, holding ponds, hay bale barriers, and silt fences, as appropriate, prior to discharge to the harbor. Graded areas will be temporarily stabilized by seeding, tacking, or mulching until permanent cover is established.

Hay bales and drainage ditches will be used to prevent sedimentation into adjacent areas.

Construction Noise

Noise related to construction activities can potentially disrupt behavior patterns of wildlife species inhabiting terrestrial communities adjacent to the construction areas. Noise from heavy equipment, for example, may be sufficiently loud and intrusive to disrupt normal behavior patterns of birds and mammals through a phenomenon known as "masking" (i.e., interference with normal auditory or communication signals). However, since the areas surrounding the construction area do not support appreciable numbers of wildlife species and will already have been impacted by the early site preparation activities, the effects of construction-related noise should be minimal.

Movement of Personnel, Equipment, and Supplies

A total of approximately 230,000 yd^3 of tunnel muck and soils excavated from the tunnel shafts and the South System pumping station will be used in conjunction with other excavated materials from construction of the secondary treatment facilities (refer to Volume III of the EIR/EID) to construct the landforms shown in Figure 8.4.1-1. Because of the quantity of earthmoving and contouring that must be conducted during construction of the inter-island transport system, the presence of numerous construction vehicles onsite would ordinarily have a deleterious effect on the wildlife inhabiting adjacent communities, primarily through roadkills and the disruption caused by the movement of equipment, personnel, and supplies. However, since the areas adjacent to the construction zones presently do not support large numbers of faunal species, and existing impacts may be associated with ongoing construction activities for the fast-track and pier projects, no long-term deleterious impact is anticipated.

8.4.3 MARINE ENVIRONMENT

Construction of the inter-island transport system will have essentially no impact on the marine environment since all surface activities, including disposal of tunnel muck and excavated materials, will be on land.

8.4.4 NOISE

Construction activity for the inter-island wastewater transport system will be confined to Nut Island and Deer Island. These activities were evaluated to determine what noise could be expected at the closest residences on Great Hill at Houghs Neck in Quincy and Point Shirley in Winthrop, respectively. Source sound levels for the proposed equipment were drawn from the Screening Report (CDM, 1986), EEI (1978), and Miller (1981). The effects of hemispherical divergence (Beranek, 1971), atmospheric absorption (CDM, 1986), and topographic barriers (Miller, 1981) were considered.

Nut Island Activity

The only construction activity at Nut Island will be the tunnel shaft. Dominant noise sources during this construction will be pile drivers, clamshell diggers, and cement trucks. Periodically, air compressors will operate for drilling in the shafts. At Great Hill, the silenced pile driving will cause peak sound levels of 62 dBA, while combined clamshell and cement truck operation will cause levels of 58 dBA. Blasting in the shaft will be shielded by blasting mats, the shaft itself, and the existing treatment facility so that the noise will not adversely affect the community.

The existing daytime ambient sound level at Great Hill is 47 dBA. All construction activity except the pile driving will produce sound levels about 10 dBA above the quietest daytime ambient. The pile-driving activity will occur for a limited time, and the sound level of the pile driving will be controlled with a silencer and a shroud (CERL, 1981).

Deer Island Activity

Activities at Deer Island will be construction of the vertical access shaft to the tunnel, the excavation and construction of the South System pumping station, and transport of spoils from the shaft, tunnel, and pumping station.

Construction of the tunnel will not be audible anywhere in the community since the boring machine will always operate within the tunnel. Ventilation for the tunnel will cause sound levels at Point Shirley to be inaudible at no higher than 19 dBA.

Silenced pile-driving activities for the tunnel shaft and pumping station will cause sound levels as high as 51 dBA at Point Shirley.

Noise due to the tunnel shaft construction, pumping station construction, and truck transport of the fill and tunnel spoils will be 55 dBA. Blasting in the shaft will be shielded and these sound levels will also be below the existing ambient.

The existing daytime ambient sound level at Point Shirley is 45 dBA. All construction activity will produce sound levels about 10 dBA above the ambient.

Section 8.4.3 References

Beranek, L.L., ed. 1971. Noise and Vibration Control. McGraw-Hill Book Co., New York.

Camp Dresser & McKee (CDM). 1986. "Report on Evaluation and Screening of Unit Processes." Prepared for Massachusetts Water Resources Authority.

Construction Engineering Research Laboratory (CERL). 1981. "Noise Control: Pile Driver Demonstration Project, Waterloo, Iowa." Technical Report N-111, p. 41.

Edison Electric Institute (EEI). 1978. "Electric Power Plant Environmental Noise Guide." Prepared by Bolt Beranek and Newman Inc., Report No. 3637.

Empire State Electric Energy Research Corporation (ESEERCO). 1977. "Power Plant Construction Noise Guide." Prepared by Bolt Beranek and Newman Inc.

Miller, L.N. 1981. Noise Control for Buildings and Manufacturing Plants. Bolt Beranek and Newman Inc.

U.S. Environmental Protection Agency (EPA). 1971. "Noise from Construction Equipment and Operation, Building Equipment, and Home Appliances." USEPA Report NTID 300.1, Figure A-8.

8.4.5 VISUAL AESTHETICS

The new South System pumping station will be the only visible component of the inter-island transport system. The pumping station will have approximate plan dimensions of 70 ft by 130 ft and will be located at an elevation of approximately 150 to 155 ft. The flat roof of the pumping station will be at an elevation of approximately 200 ft.

An assessment of the visual impacts of the pumping station will be made within the context of adjacent structures, which will consist of the primary treatment and North System grit-removal facilities. This assessment will be made in conjunction with the recommended site plan, which will be addressed in the Treatment Plant EIR/EID, Volume III.

8.4.6 TRAFFIC

Transportation requirements to Deer Island for construction of the inter-island conduit include initial transport of construction equipment, periodic transport of materials to and from the island, and daily transport of workers to and from the site during all phases of construction. Transportation requirements to Nut Island during construction of the vertical access shaft include the same elements.

It is expected that the on-island and onshore pier facilities will be complete and operating by the time inter-island conduit construction begins. Construction equipment and materials will be transported to and from Deer Island by barge using the newly constructed piers. To identify potential transportation impacts for the inter-island conduit, it is assumed that construction workers will be transported to Deer Island by private automobile. Volume III of the Secondary Treatment Facilities Plan will examine the potential for busing workers to Deer Island.

Traffic impacts associated with worker ferry transport and the onshore pier facilities have been addressed by others for the MWRA. These studies are described in the Final Environmental Impact Reports for On-Shore Water Transportation and On-Island Water Transportation Facilities. A potential onshore pier site has been located in Quincy. The above reports have examined

construction traffic impacts to Quincy and surrounding communities. The potential traffic impacts in these communities associated with the inter-island conduit construction have not been examined and are not discussed in this report.

Material transport estimates have been developed using daily truck trips. Most material will be transported over water by barge. However, it must first be transported over land to the mainland pier facility. It is possible that material could be trucked to the onshore piers if rail transport is not available. Communities surrounding the piers thus could be affected by construction truck traffic. In general, it has been estimated that each truck can carry 20 yd^3, or 20 tons, of material.

Baseline Traffic

Current activities on Deer Island include operation of an existing wastewater primary treatment plant, fast-track construction improvements at the plant, and operation of the Deer Island House of Correction. All fast-track improvements are scheduled for completion by the end of 1989, before the start of influent conduit construction.

Current automobile round trips associated with the existing treatment plant operation average between 60 and 70 per day. The plant is operated in three shifts, with most trips occurring during off-peak hours. Daily truck trips to the treatment facility average between 10 and 15, distributed over the course of a day.

Operation of the House of Correction results in 120 automobile round trips per day. These trips are also distributed over three shifts, with most occurring in off-peak periods. The facility is scheduled to be vacated by the end of 1989.

Inter-Island Wastewater Transport System Traffic Estimates

Estimates of daily automobile and truck trips resulting from inter-island tunnel construction are described in detail in Section 7.5.1.

The wastewater will travel from Nut Island to Deer Island. The required South System pumping station will be located on Deer Island. An average of 30 to 50 workers per day, with a peak of 40 to 45 workers, will construct the pumping station over a three-year period. Approximately 14,600 yd^3 of concrete will be placed.

Table 8.4.6-1 summarizes the estimated number of daily worker and truck trips to Deer Island that could be generated during conduit construction. Workers associated with tunnel boring will be divided into four daily shifts. Workers for the other activities will be divided into three daily shifts. Table 8.4.6-1 does not reflect truck trips that could result if it proves necessary to remove excavated materials off Deer Island.

TABLE 8.4.6-1

ESTIMATED TOTAL VEHICLE MOVEMENTS GENERATED BY CONDUIT CONSTRUCTION

	Automobile trips		Truck trips	
Facility or project	Deer Island	Nut Island	Deer Island	Nut Island
Existing plant	6070		1015	
Vertical shafts	2530	2530	15	15
Tunnel boring	175185		1015	
Tunnel lining	105115		1015	
Pumping station	3035			

Table 8.4.6-2 lists quantities that have been used for design purposes as an upper bound for daily truck volumes (C.E. Maguire, 1987). Daily truck trips that could result from the activities described above are within the proposed upper limit. The Winthrop intersection analyses have used 24 trucks per hour for movements through the intersection as a conservative estimate.

TABLE 8.4.6-2

UPPER LIMITS OF DAILY TRUCK VOLUMES

Period	Peak trucks per day	Peak trucks per hour*
1990-1993	190	24
1993-1997	137	17
1997-1999	113	10

*Assumes an 8-hour delivery period

Estimated daily automobile trips to and from Deer Island that could occur during tunnel construction range from 115 to 290 round trips per day. Of these trips, approximately 60 to 70 per day are associated with operation of existing treatment facilities on Deer Island.

Construction of a vertical access shaft could generate a maximum of 30 automobile round trips per day to Nut Island.

Estimated daily truck round trips to and from Deer Island range from 25 to 45 per day. Truck trips could be increased by at least 10 to 15 per day if removal of material excavated from the tunnel becomes necessary. The estimated truck volumes caused or affected by the influent conduit construction are, therefore, less than 45 round trips per day wich is within the maximum 190 round trips per day that has been used for design purposes as an upper limit of truck volume. The apparent reserve margin for truck movements per day may, however, be absorbed by other simultaneous construction on the islands. Tunnel construction activities will coincide with construction of the effluent outfall and the primary wastewater treatment facilities at Deer Island and construction of the preliminary treatment facilities at Nut Island.

Construction of the primary treatment facilities will occur between 1991 and 1996, the Nut Island headworks construction will occur from 1993 to 1995, and the effluent outfall construction will begin in 1990 and is scheduled for completion in 1995. Aggregate truck and automobile volumes that could result because of construction schedule overlaps among various projects have not been estimated.

Most of the construction workers, material, and equipment traveling to and from Deer Island will be ferried or barged over water to new pier facilities. At times it may be necessary to transport to Deer Island over land, through Winthrop. Communities potentially affected by construction traffic movements to Deer Island, Nut Island, and Long Island have been addressed in previous reports to MWRA. These reports have been identified in previous paragraphs.

Winthrop traffic impacts resulting from construction automobile and truck traffic have been examined. A discussion of potential construction impacts to Winthrop is summarized in the paragraphs that follow. Appendix A contains a more detailed description of the methodology used in this analysis.

Mainland access to Deer Island is through Winthrop. Observations of the existing traffic environment have shown that local roadways are narrow and that vehicular movements are generally dispersed, irregular, and at moderate speeds.

Peak conditions have a very short duration in Winthrop. A peak hour can be identified in the morning and afternoon. However, truly peak conditions exist only for a 20-minute period in each case. On average, significant queues do not develop at intersections in Winthrop.

Two truck routes were identified for truck movements to and from Deer Island. One route is the existing Deer Island truck route. It avoids the town center, but passes through the majority of Winthrop. A limiting factor is that the Saratoga Street Bridge carries a load limit restriction of 33 tons.

An alternate route is northern and western portions of Route 145, with access to Winthrop through the town of Revere. This route is more direct and requires less penetration of Winthrop. However, approximately 0.7 miles of the route is closed to trucks.

For both routes, access to the area's arterial highways is hampered by a bridge that is restricted to 33 tons. Trucks must use a one-mile detour to avoid this restriction. The detour, however, is along main thoroughfare roadways.

Intersection level of service analyses have been performed for ten intersections along the two routes that could be affected by increased vehicle movements. Intersections are generally the limiting factor for arterial capacities. Level of service shows the vehicle capacity capabilities of an intersection. Analyses were performed using a proprietary computer program based on American traffic engineering practice.

The analyses assumed the worst-case scenario for truck movements. The intersections were first analyzed under existing peak hour conditions. The estimated maximum hourly truck volume was then added to the existing peak condition volume of movements to and from Deer Island and analyses were performed under these future conditions. All intersections were analyzed assuming phased signal control.

Accident history data for the intersections, taken over a six-year period, were obtained from the Massachusetts Department of Public Works. Table 8.4.6-3 provides a summary of these data for the ten intersections.

The data show that a majority of accidents involved two vehicles in traffic and either a rear or an angle collision. Injuries occurred in 81 out of the 373 accidents. There were no fatal accidents.

The intersections at Bennington and Saratoga Streets and Main and Pleasant Streets show a combined total of 162 accidents. These two intersections serve as main entry points into Winthrop. Three additional intersections that show a relatively high number of accidents are at Main Street, Revere Street, and Winthrop Avenue; Shirley Street and Veterans Avenue; and Revere Street and Shirley Street. All three intersections are currently controlled by flashing signals. Of the unsignalized intersections, the intersection of Shirley Street and Washington Avenue, which has commercial businesses on each corner, shows the highest accident rate, with 26 accidents occurring within the six-year period.

Analysis has shown that overall service levels remain at "A" when trucks and vehicles are added to existing intersection traffic volumes and at least basic signal phasing is used for all

TABLE 8.4.6-3
ACCIDENT HISTORY SUMMARY

Intersection	Total Accdnts	Accdnts W/ Injry	Accdnts W/ Fatal	Vhcl Invlvd Per Accident 1	2	3	>4	Injury Nmbr Per Accident 1	2	3	>4	Motor Vhcl Collision with: Ped	Mvng Vhcl	Prkd Vhcl	Objct Off-rd	Objct By-rd	Othr	Collision Type Rear	Angl	Head	Othr	Traffic Control Type Stp Sgn	Wrng Sgn	Sgnl	No Sgnl	No Cntrl	Othr
Bennington/Saratoga	101	21	0	7	83	10	1	14	5	2	0	4	71	16	2	1	7	33	47	2	19	3	0	61	1	35	1
Main/Pleasant	61	10	0	2	54	1	2	6	4	0	0	0	53	3	1	2	2	28	21	3	9	3	0	37	0	20	1
Main/Hermon	13	4	0	3	7	1	2	2	1	1	0	1	7	1	0	1	3	3	6	1	3	1	0	7	0	5	0
Main/Revere/Winthrop	47	9	0	10	35	1	1	7	2	0	0	2	28	7	2	1	7	13	23	1	10	1	3	22	0	19	5
Revere/Shirley	26	8	0	4	21	0	1	8	0	0	0	2	18	3	2	0	1	5	14	1	6	4	2	10	0	10	2
Shirley/Veterans	39	9	0	0	35	3	1	6	3	0	0	0	32	4	0	0	3	4	28	1	6	20	0	9	0	10	0
Veterans/Washington	5	2	0	2	2	0	1	2	0	0	0	1	0	3	0	0	1	2	1	0	2	0	0	0	0	5	0
Washington/Shirley	26	7	0	2	23	1	0	6	0	1	0	1	15	6	1	0	3	5	19	0	2	3	0	0	0	22	1
Veterans/Winthrp Shr	4	0	0	0	4	0	0	0	0	0	0	0	3	0	1	0	0	0	3	0	1	3	0	0	0	1	0
Crest/Revere/Highland	51	11	0	3	45	3	0	9	2	0	0	0	41	3	1	1	5	14	24	4	9	27	0	0	0	23	1
Totals	373	81	0	33	309	20	9	60	17	4	0	11	268	46	10	6	32	107	186	13	67	65	5	146	1	150	11

*Accident Data is taken from Massachusetts Department of Public Works computer printouts for 1 January 1975-31 December 1980 and 1 January 1983-31 December 1983.

intersections. In addition, any negative traffic impacts likely to occur can be easily mitigated through changes in signal phasing, addition of signalization to unsignalized intersections, disallowance of roadside parking, and controlled scheduling of truck and worker movements.

Previous studies have shown that specific approaches of some unsignalized intersections are operating at service level "D" during the critical peak hour. As the analysis shows, installation of a traffic signal at all unsignalized intersections would improve service levels to acceptable levels on all approaches. Phased control on all intersections would help ensure safe movement of trucks to and from Deer Island.

Intersections that are currently operating under flashing control can easily be reset to phased control. Analysis showed that these intersections operate at an "A" service level when signals are phased.

Finally, scheduling of truck and worker movements so that Deer Island traffic is not added to the morning and afternoon peak hours can also mitigate any impact to the intersections.

8.4.7 HISTORIC AND ARCHAEOLOGICAL RESOURCES

Neither the location of the new South System pumping station, nor the location of the vertical access shaft on Nut Island, is in proximity to identified archaeological or historic resources. Tunnel muck and excavated materials from the vertical access shafts will be used on Deer Island to construct landforms, or as backfilling material for the new primary treatment facility. The impacts of the disposal of these materials, if any, on the nearest historical structures (i.e., the Steam Pumping Station and the Farmhouse) will be described in the Treatment Plant EIR/EID, Volume III.

8.5 MITIGATION MEASURES

A significant mitigation package was developed as an integral part of MWRA's decision to site the new secondary treatment facilities on Deer Island. Because MWRA is committed to alleviating the impacts associated with the construction and operation of the treatment facilities, the previous mitigation commitments are also an integral part of the facilities planning process.

The mitigation commitments address a broad range of environmental, technical, and institutional issues for both construction and operation of the secondary treatment facilities.

Summary descriptions of each of the mitigation commitments and a statement of the applicability of each commitment for use as an evaluation criterion were provided in the Technical Memorandum Proposed Criteria For Detailed Evaluation of Alternatives, Secondary Treatment Facilities Plan, May 13, 1987. These commitments were reviewed to categorize all necessary mitigation commitments and associated environmental controls that support the inter-island transport system plans. A summary of these commitments and environmental controls specific to

the inter-island transport system is provided below.

- o **Flow and Growth**

  The design basis for the inter-island transport system has taken into consideration the existing South System flow rates, as well as any projected increases described in the Flows and Loads Technical Memorandum (Interim Report, Secondary Treatment Facilities Plan Detailed Evaluation of Alternatives, July 10, 1987).

- o **Noise Control**

  Consideration of potential mitigation measures has been given to all significant noise-producing activities. Construction activities that affect off-island noise will be limited to one shift, daytime operation. Pile-driving noise will be controlled by the use of shrouds.

- o **Barging and Busing**

  To mitigate impacts associated with the transportation and disposal of tunnel muck and excavated materials from the pumping station and access shafts, all materials will be disposed of on Deer Island as backfill material. Materials excavated from the Nut Island access shaft will be disposed of on Nut Island.

8.6 INSTITUTIONAL CONSIDERATIONS

The major institutional considerations for the inter-island transport system include timely implementation, permitting, internal and external (to MWRA) coordination, demand for unique construction resources, and flexibility to meet project phasing.

Timely implementation and flexibility to meet project phasing are considered together. The estimated tunnel construction schedule is 36 months, based on assumptions regarding rock strength and uniformity. These assumptions are reasonable considering the information currently available. However, there is no information regarding the rock characteristics at the tunnel depth along the proposed tunnel route. Unexpected rock conditions could affect the schedule and the method of construction. At best, the construction schedule could be shortened by several months and the use of a tunnel boring machine would be confirmed. At worst, the construction schedule could be significantly lengthened, and it may be necessary to employ drill and blast techniques for a portion, or all of, the tunnel. A detailed geotechnical program consisting of a series of deep rock borings along the tunnel alignment is required to develop the necessary information.

To allow for the the possibility of encountering unexpected rock conditions and still meet the December 1994 tunnel completion date, it is recommended that the geotechnical field program begin as soon as the tunnel alignment is selected. Preferably, this program would be performed

between April and October of 1989. It must be performed no later than the good weather season of 1990 if the December 1994 completion date is to be met.

Internal and external coordination and demand for unique construction resources are considered together. It is anticipated that three major projects with similar construction resource requirements will be constructed concurrently. Two of these projects, the inter-island transport system and the effluent outfall system, are part of the new wastewater treatment facilities. The outfall system is the subject of Volume V, Outfall.

The third project is the third harbor tunnel. To ensure the availability of labor, equipment, and supplies, it will be necessary to be cognizant of the requirements of all three projects.

Permitting is expected to require two years to complete. This effort must be initiated no later than the start of detailed design. For example, a permit will be required from the U.S. Coast Guard to allow the geotechnical field program to proceed. Therefore, as shown on Figures 8.1.1-1 and 8.1.2-4, permitting must begin by 1 December 1989.

If the design contract is awarded earlier, as recommended, it will be necessary to begin the permitting effort earlier.

The major federal and state permits and approvals required for the inter-island transport system are identified in Table 8.6-1.

As noted in Section 5.2, Nut Island has recently been rezoned by the City of Quincy as "Open Space." This zoning reclassification would prohibit building structures on Nut Island, a reclassification which is in contradiction with the existing land use on Nut Island. Volume III, the Treatment Plant EIR/EID, will describe facility plans which will remove the existing Nut Island treatment plant, and replace it with a headworks facility which will support the inter-island conveyance of South System wastewater, described herein. The Secondary Treatment Facilities Plann has interpreted the Nut Island rezoning classification to refer to the approximately 13 acres of land on Nut Island, which will become available as open space following the removal of the existing treatment facilities. As such, the rezoning classification is not expected to impact timely implementation of the recommended plan.

TABLE 8.6-1

INTER-ISLAND TRANSPORT SYSTEM PERMITTING MATRIX

Permit/Approval AGENCY	Activity Requiring Permit/Approval
Federal	
NEPA EIS/FONSI (EPA)	EPA plans to prepare an EIS for the inter-island conduit
Private Aid to Navigation (USCG)	Placement of temporary or permanent floats, moorings, etc., in areas potentially affecting navigation
FAA Notice of Proposed Construction and Alternation (FAA)	Construction of structures within the vicinity of a public use airport
State	
EOEA Certification (EOEA-MEPA Unit)	State permitting, approval, or funding activities for projects meeting specified threshold criteria
Water Quality Certification (DEQE/DWPC)	Federal or state permitting activities for actions involving discharges to water
CZM Consistency Review (Mass. CZM)	Federal funding/permitting action for activity located within or affecting the coastal zone of Massachusetts
Section 106 Historic preservation Review (MHC)	Removal/modification of structures eligible for inclusion on the National Register of Historic Places

Abbreviations

CZM - Coastal Zone Management
DEQE - Department of Environmental Quality Engineering
DWPC - Division of Water Pollution Control

EIS	-	Environmental Impact Statement
EOEA	-	Executive Office of Environmental Affairs
EPA	-	U.S. Environmental Protection Agency
FAA	-	Federal Aviation Administration
FONSI	-	Finding of No Significant Impact
MEPA	-	Massachusetts Environmental Policy Act
MHC	-	Massachusetts Historic Commission
NEPA	-	National Environmental Policy Act
NPDES	-	National Pollutant Discharge Elimination System
USCG	-	U.S. Coast Guard

Section 9

9.0 PUBLIC PARTICIPATION SUMMARY

9.1 INTRODUCTION

In facing the monumental tasks associated with the successful implementation of the Deer Island Secondary Treatment Facilities Plan (STFP), the Authority instituted a comprehensive public participation effort. The measures included in this summary were designed to meet federal and state regulatory requirements associated with the project, to satisfy grant conditions, and to provide the most meaningful avenues of public input into the critical decisions to be made by the Authority. Through this program, the Authority's dialogue with the public has been ongoing and important policy decisions have been made and will continue to be made within the context of maximum public knowledge and participation.

9.2 COORDINATION WITH OTHER HARBOR CLEAN-UP PROJECTS

Because the total Harbor clean-up program consists of many simultaneous efforts, the public participation activities associated with the STFP have been closely coordinated with public participation efforts being undertaken for other projects. Public participation coordination has mirrored similar efforts on the technical side, particularly with regard to overlapping concerns. Coordination occurs on several levels:

- Engineering and Public Affairs project staff and technical and public participation consultants for both the Deer Island Secondary Treatment Facilities Plan and Residuals Management Facilities Plan (RMFP) have met at least monthly to discuss coordination efforts and to review schedules and agendas for upcoming meetings.

- The public participation programs are coordinated through the Authority's Public Participation Coordinator and augmented by other Public Affairs staff, including media, intergovernmental and community relations personnel, particularly when project components have a direct bearing on a particular community.

- The Citizens' Advisory Committee (CAC) have served to review work associated with both the Secondary Treatment Facilities Plan and the Residuals Management Facilities Plan and have been kept informed of developments on other projects, such as water transportation, CSOs and the setting of local limits for industrial discharges.

9.3 CITIZENS' ADVISORY COMMITTEE

In July, 1986 the MEPA Unit of EOEA served notice of the formation of a Citizens' Advisory Committee for the STFP in the Environmental Monitor. In addition, notices were mailed to several hundred individuals and organizations and an announcement was placed in On the Waterfront, the MWRA newsletter, which was mailed to over 1500 individuals, groups and agencies.

Pursuant to discussions among agencies, it was decided that this CAC would serve to review both the STFP and the RMFP. Active members of the Authority's informal CAC from Phase I of the RMFP were solicited for nominations to the STFP CAC.

On October 10, 1986, EOEA Secretary James S. Hoyte appointed the CAC, which consists of 28 representatives and 15 alternate members. (See Table 9-1). The CAC consists of representatives of environmental, business, community, government and other interests. In addition, agency representatives are serving in a non-voting capacity.

Technical support from Authority staff and consultants has been provided to assist in interpreting data and reports for the CAC. Administrative support from Authority Public Affairs staff and public participation subconsultants includes preparation of agendas, minutes and CAC reports, and scheduling of meetings and workshops. In addition, funds were allocated in the Authority's Capital Expenditure Budget to cover expenses the CAC may incur.

The CAC has met on a regular monthly basis and has chosen to form subcommittees to examine specific issues. In addition, a workshop on project scoping took place in February, 1986. The subcommittees have met on an as needed basis, generally on the fourth Monday of each month from 4:30 to 6:30 p.m. at a location agreeable to the majority of participants. Sub-group meetings have been scheduled for the early part of each month as needed. Materials are distributed to the CAC at the end of the meeting for discussion at the following month's meeting. At times it has been necessary to distribute these materials through the mail, but sufficient time is allocated for the CAC members to review the information and prepare for the discussion.. Agendas, minutes and certain other materials are also distributed prior to the CAC meetings.

9.4 TECHNICAL ADVISORY GROUP

As an adjunct to the public participation program, a technical advisory group has been formed to provide a mechanism for input from involved agencies as well as technical advice and support to the Citizens' Advisory Committee. Representatives of agencies involved in regulatory, permitting, funding or other capacities were solicited by the MEPA Unit of EOEA for membership on the TAG, as were former members of the siting EIS TAG formed under EPA's auspices. A list of those representatives is attached in Table 9-2.

In order to benefit from the Authority's presentations to the CAC and to assist the citizen representatives in understanding technical issues, TAG representatives are invited to attend all CAC meetings and workshops. They are provided with documents in advance of the meetings and are asked to provide written review and comment, to be returned to the Authority in a timely fashion.

With this arrangement, the Authority can benefit from the advice of the TAG without devoting large portions of the CAC's agenda to technical discussions which the citizen representatives may not understand. The TAG is also free to meet on its own or at the request of the agencies, such as the EPA.

9.5 PUBLIC MEETINGS

Public meetings fall into several categories:

A. Forums--In order to clarify the Authority's overall program for interested constituent groups and the public at-large, a forum was held in Boston in January, 1987. At this forum a total picture of the Harbor clean-up effort was presented. Two additional forums are planned for January and May of 1988.

B. Public Information Meetings--Public information meetings have been held at project milestones, including: Outfall Screening and Technology, in March at Lynn and Quincy; and Early Site Preparation, Alternative Site Layouts and recommended Inter-Island alternatives in July in Boston. A public meeting on the status of facilities planning, excluding the outfall work, will take place in September. A public meeting devoted to the status of the outfall study will take place in November at two locations.

C. Meeting with Impacted Communities--In addition to its attempts to educate the CAC and the public at-large, the Public Participation Program addresses the concerns of communities to be impacted by the results of the decisions made during the study. The Authority's Community Relations liaison with the Town of Winthrop has attended monthly meetings of the Town's Representative Citizens Committee to keep them abreast, not only of ongoing operational and fast-track upgrade issues at the existing primary plant, but also of the progress of the Secondary Treatment Facilities Plan.

   The Authority also holds regular public meetings with the Winthrop community at-large to update them on the STFP and to hear public concerns regarding key decisions. Similarly, the Authority's Boston/Quincy Community Relations Coordinator has attended monthly Nut Island CAC meetings. The Community Relations Coordinator for the northern sector of the MWRA service area will provides similar coordination efforts to communities which may be potentially affected by outfall siting decisions.

   Local elected and appointed officials are kept informed of all developments with the STFP relative to their concerns through the Public Participation and Community Relations Coordinators.

D. Other Meetings

There are three Public Hearings scheduled to be held at three locations each: one on Site Preparation background and Inter-Island Conduit; one on Treatment Plant and Institutional Considerations; and one on Outfall. Special request meetings with the MWRA Advisory Board and other groups and organizations have taken place.

E. Responsiveness Summaries

Responsiveness summaries of all public information meetings and public hearings are available within four (4) weeks after the public meeting.

9.6 OTHER INFORMATIONAL ACTIVITIES

The STFP project team has been involved in development of informational materials, including newsletters, public service announcements, press releases, an educational display, brochures, responsiveness summaries, and fact sheets for use at public and CAC meetings, as well as for distribution through mailing lists, repositories, schools, clubs, and other community information centers.

9.7 LIST OF REPOSITORIES

Winthrop Public Library
Attn: George Pillion
2 Metcalf Square
Winthrop, MA 02152
846-1703

Hours of service: Mon., Tues., Thurs. 1-9; Wed. 10-9; Fri. 10-6; Sat. 10-5

Thomas Crane Public Library
Attn: Linda Beeler--Reserve Dept.
40 Washington Street
Quincy, MA 02169
471-2400

Hours of service: Mon.-Thurs. 9-9; Wed. 10-9; Fri. 10-6; Sat. 10-5

Hough's Neck Community Center
Attn: Patricia Redlen
1193 Sea Street
Quincy, MA 02169

Hours of service: Mon. 9-8:30; Tues.-Fri. 9-4

Boston Public Library
Attn: Jennifer Nason
Document Dept./Rm. 341
State House
Boston, MA 02133
727-2590

Hours of service: Mon.-Fri. 9-5

Wellesley Public Library
530 Washington Street
Wellesley, MA 02181

Hours of service: Mon.-Thurs. 10-9; Fri. 10-7; Sat. 9-5; Sun. 2-5

Malden Public Library
Walpole Street
Norwood, MA 02062

Hours of service: Mon.-Fri. 9-9; Sat. 9-5; Sun. 1-5

MWRA Library
Charlestown Navy Yard
100 First Avenue
Boston, MA 02129
242-6000

Hours of service: Mon.-Fri. 8:30-5

(This is a central reference location with full project histories and other information available to CAC members and the public.)

9.8 MAILING LIST

The MWRA's computerized mailing list currently consists of over 2000 individuals, groups and agencies, which fall into the following categories:

- MWRA Advisory Board (local officials)
- Legislators (federal, state, regional, local)
- Media
- Agencies (federal, state, regional, local)
- Groups/Organizations
- Individuals

In addition, issue codes have been assigned to mailing list entries, so the list may be sorted by issue code, zip code, or town. Attendees at public meetings are added to the mailing list.

9.9 PUBLIC PARTICIPATION SCHEDULE

The CAC meeting agenda is reviewed with the chairman and executive committee of the CAC prior to each meeting. The long-term agenda is reviewed with the CAC on a quarterly basis and updated as needed, with their input. For a complete listing of meetings that have taken place and planned meetings, please refer to the Public Participation Schedule (Table 9.3).

TABLE 9-1
SECONDARY TREATMENT FACILITIES PLAN
CITIZENS' ADVISORY COMMITTEE
REPRESENTATIVES AND ALTERNATES

Lois Baxter
17 Circuit Road
Winthrop, MA 02152
Alternate
846-3040 (h)

William Benson
52 Grinnell Street
Greenfield, MA 01301
Representative
(413) 773-5267

Peter Blanchard
Mass. Bankers Association
Prudential Tower, Suite 550
Boston, MA 02199
Representative
542-1837

Mike Brother
USGS
Quisset Campus
Woods Hole, MA 02543
Alternate
548-8700

Polly Bradley
SWIM
33 Summer Street
Nahant, MA 01908
Representative
581-0075

Brad Butman
USGS
Quisset Campus
Woods Hole, MA 02543
Representative
548-8700

Eugene Canty
2 Lafayette Terrace
Nahant, MA 01908
Alternate
581-0281

Michael Cheney
94 Rock Island Road
Quincy, MA 02169
'lternate
'93

oby
Honeywell Bull, Inc.
300 Concord Road
Billerica, MA 01821
Representative
671-3614

Sharon Dean
N. E. Aquarium
Central Wharf
Boston, MA 02110
Representative
973-6552

Clifford deBaun
Sierra Club New England
1386-A Canton Ave.
Milton, MA 02186
Alternate
333-0173

Leonard DeModena
182 Pinceton Street
East Boston, MA 02128
Representative
727-1263 (w)

Emilie DiMento
Winthrop Concerned Citizens
118 Woodside Ave.
Winthrop, MA 02152
Representative
826-9406

Mark Doran
Associated Industries of Mass.
462 Boylston Street
Boston, MA 02116
Representative
262-1180

Joe Duggan
Greater Boston Chamber of Commerce
125 High Street
Boston, MA 02110
Representative
426-1250

William Elliott
2 Bargate Lane
Hadley, MA 01035
Representative
(413) 586-8861

Astrid Glynn
Glynn & Dempsey, P.C.
One Federal Street
Boston, MA 02110
Representative
523-7420

Lydia Goodhue
The Boston Harbor Associates
90 Dover Road
Wellesley, MA 02181
Representative
235-5370

Phillip Goodwin
Mass. Bay Yacht Clubs Assoc.
73 Bicknell Street
Quincy, MA 02169
Representative
471-5913

Alice Hennesey
Boston City Council
One City Hall Plaza
Boston, MA 02201
Alternate
725-4000

Stephen Hunt
Save the Harbor/Save the Bay
3 Joy Street
Boston, MA 02108
Alternate
742-7283

Betsy Johnson
Mass. Audubon - Boston
3 Joy Street
Boston, MA 02108
Representative
367-1026

Ruth Kaminski
25 Moosehill Road
Leicester, MA 01524
Representative
892-3121

Mary Kelley
Winthrop Conservation
Commission
48 Sargent Street
Winthrop, MA 02152
Representative
846-9450

Robert Luongo
Office of Community Development
City Hall, 500 Broadway
Chelsea, MA 02150
Alternate
889-0700

Joseph MacRitchie
110 Sonoma Road
Squantum, MA 02171
Representative
773-1380

Tom McNiff
118 Grandview Ave.
Winthrop, MA 02152
Alternate
846-3782

Herbert Meyer
Mystic River Watershed Assoc.
276 Massachusetts Avenue
Arlington, MA 02174
Representative
643-2157

Phil Mitchell
Construction Industries of Mass.
P.O. Box 667
Norwood, MA 02062
Alternate
551-0182

Martin Nee
c/o Rep. M. Flaherty
State House, Room 138
Boston, MA 02133
Representative
722-2396

Robert Noonan
Winthrop Board of Selectmen
Town Hall
Winthrop, MA 02152
Representative
846-1852

Marjorie O'Neil
212 Chestnut Street
Brookline, MA 02146
Alternative
232-6260

Martin Pillsbury
Metropolitan Area Planning Council
110 Tremont Street
Boston, MA 02108
Representative
451-2770

John Piotti
MWRA Advisory Board
6 Beacon St., Room 925
Boston, MA 02108
Representative
742-7561

Stewart Sanders
Mystic River Watershed Assoc.
73 Fairmont Street
Belmont, MA 02178
Alternate
489-3120

John Scalcione
36 Frankfort Street
East Boston, MA 02128
Representative
589-3926

Lawrence Schafer
26 Emerson Street
Newton, MA 02158
Representative
965-9888

Judith Schlosser
Office of Community Development
City Hall, 500 Broadway
Chelsea, MA 02150
Representative
889-0700 (w)

Eric Thomas
Utility Contractors' Association
150 Wood Road, Suite 305
Braintree, MA 02184

Jack Walsh
63 Sea Avenue
Quincy, MA 02169
Representative
471-6191 (h)

Virginia Wilder
Office of Community Development
Town Hall
Winthrop, MA 02152
Alternate
846-1852

Nicholas Yannoni
31 Lafayette Road
Newton, MA 02162
Alternate
377-2206

TABLE 9-2
SECONDARY TREATMENT FACILITIES PLAN
TECHNICAL ADVISORY GROUP

Karen Adams
US Army Corps of Engineers
424 Trapelo Road
Waltham, MA 02154
TAG
647-8237

Libby Blank
Boston Water and Sewer Commission
10 Post Office Square
Boston, MA 02109
TAG
426-6046

Susan Bregman
Boston Traffic and Parking
Boston City Hall
Boston, MA 02201
TAG
565-3549

Leigh Bridges
Dept. of Fisheries, Wildlife & Env. Enf.
100 Cambridge Street, 19th Floor
Boston, MA 02202
TAG
727-3193

Eric Buehrens
Department of Environmental Mgmt.
225 Friend Street
Boston, MA 02114
TAG
727-3160

Ken Carr
US Fish & Wildlife Service
P.O. Box 1518
Concord, NH 03301
TAG

Roberta Ellis
MASSPORT Planning Department
10 Park Plaza
Boston, MA 02116
TAG
973-5390

David Graber
118 Larson Road
Stoughton, MA 02072
TAG
341-0390

Fred Hoskins
Executive Office of Enconomic Affairs
1 Ashburton Place
Boston, MA 02108
TAG
727-8380

Steve Lipman
DEQE/DWPC
One Winter Street
Boston, MA 02108
TAG
292-5698

Christopher Mantzaris
US Nat'l Marine Fisheries Serv.
14 Elm Street
Gloucester, MA 01930
TAG

Julia O'Brien
MDC Planning Office
20 Somerset Street
Boston, MA 02108
TAG
727-9693

William Patterson
US DOI, Off. of Env. Proj.
Review
15 State Street
Boston, MA 02109
TAG
223-5517

Myra Schwartz
BRA, Harbor Planning and
Develop.
1 First Ave., 2nd Floor
Charlestown, MA 02129
TAG
242-2282

Brona Simon
Massachusetts Historical Commission
80 Boylston Street
Boston, MA 02216
TAG
727-8470

Linda Smith
BRA, Harbor Planning
1 First Ave., 2nd Floor
Charlestown, MA 02129
TAG
242-2282

Jan Smith
Office of Coastal Zone Mgmt.
100 Cambridge Street, 20th
Floor
Boston, MA 02202
TAG
727-9530

David Standley
Center for Environmental Mgmt.
Curtis Hall, Tufts, University
Medford, MA 02155
TAG
381-3486

Mike Tierney
Exec. Office of Communities & Development
100 Cambridge Street, 14th Floor
Boston, MA 02202
TAG
727-7765

Dave Tomey
US EPA
JFK Federal Bldg, Rm. 2100 B
Boston, MA 02203
TAG
565-3552

Lt. Commander Michael Wade
U.S. Coast Guard, Marine Safety Div.
477 Commercial Street
Boston, MA 02109
TAG
223-8441 (Douglas Brown)

Kim Zullo
MASSPORT Development Dept.
10 Park Plaza
Boston, MA 02116
TAG

Appendix A

APPENDIX A

AMBIENT SOUND PRESSURE LEVELS
SEPTEMBER 1986, WINTHROP, MA

TABLE A-1

AMBIENT SOUND PRESSURE LEVELS,
September 3, 1986, Winthrop, MA

MEASUREMENT LOCATION (TIME OF SURVEY)	L90 dBA	RESIDUAL OCTAVE BAND CENTER FREQUENCY, HZ								
		31	63	125	250	500	1000	2000	4000	8000
1. Engineers House		Not Collected								
2. 150 Tafts (1300-1310)	45	Not Collected								
4. Tafts & Otis (1337-1347)	43	Not Collected								
5. Shirley & Triton (1450-1500)	44	Not Collected								
6. Siren & Triton (1414-1424)	40	Not Collected								
7. Harbor View (1500-1510)	42	Not Collected								

NOTE:

Weather conditions: Wind E, < 5 mph, overcast.

TABLE A-2

AMBIENT SOUND PRESSURE LEVELS,
September 5, 1986, Winthrop, MA

MEASUREMENT LOCATION (TIME OF SURVEY)	L90 dBA	RESIDUAL OCTAVE BAND CENTER FREQUENCY, HZ								
		31	63	125	250	500	1000	2000	4000	8000
1. Engineers House		Not Collected								
2. 150 Tafts (1000-1015)	51	58	60[1]	63	53	42	37	33	28	25
4. Tafts & Otis (1037-1047)	43	55	55	50	41	38	38	30	30	17
5. Shirley & Triton (1053-1104)	42	55	58	51	49	45	40	32	27	20
6. Siren & Triton (1115-1126)	44	57	57	53	45	38	35	29	29	21
7. Harbor View (1139-1152)	49	61	60[2]	57	49	44	41	37	32	32

NOTES:

[1] Diesels just audible, pulses to 70 dB.
[2] Diesles audible, pulses to 65 dB.

Weather conditions: Winds Light, Southerly, Sky Clear.

TABLE A-3

AMBIENT SOUND PRESSURE LEVELS,
September 16, 1986, Winthrop, MA

MEASUREMENT LOCATION	L90	RESIDUAL OCTAVE BAND CENTER FREQUENCY, HZ								
(TIME OF SURVEY)	dBA	31	63	125	250	500	1000	2000	4000	8000
1. Engineers House (2200-2210)	53	60	65	60	56	56	49	44	38	27
2. 150 Tafts (2240-2250)	48		Not Collected							
4. Tafts & Otis (2300-2310)	47		Not Collected							
5. Shirley & Triton (2420-2430)	46		Not Collected							
6. Siren & Triton (2339-2349)	46		Not Collected							
7. Harbor View (2358-0008)	48		Not Collected							

NOTE:

Weather conditions: Winds N at 5 mph.

TABLE A-4

AMBIENT SOUND PRESSURE LEVELS,
September 17-18, 1986, Winthrop, MA

MEASUREMENT LOCATION (TIME OF SURVEY)	L90 dBA	RESIDUAL OCTAVE BAND CENTER FREQUENCY, HZ								
		31	63	125	250	500	1000	2000	4000	8000
1. Engineers House (0030-0049)	47	60	65	56	51	43	40	27	33	19
2. 150 Tafts (0010-0024)	40	55	60[1]	53	42	35	29	22	18	15
4. Tafts & Otis (2355-0005)	38	51	52	49	41	36	29	22	15	14
5. Shirley & Triton (2338-2350)	42	55	55	56	49	39	34	26	22	15
6. Siren & Triton (2322-2333)	47	57	57	52	50	46	39	28	25	16
7. Harbor View (2304-2314)	48	53	61	52	45	41	38	38	32	20

NOTE:

[1] Diesels audible, level varies to 70 dB with pulses.
Weather conditions: Wind SW - Light to calm.

TABLE A-5

AMBIENT SOUND PRESSURE LEVELS,
September 18-19, 1986, Winthrop, MA

MEASUREMENT LOCATION (TIME OF SURVEY)	L90 dBA	RESIDUAL OCTAVE BAND CENTER FREQUENCY, HZ								
		31	63	125	250	500	1000	2000	4000	8000
1. Engineers House (0025-0036)	48	60	65[1]	57	47	42	37	32	28	18
2. 150 Tafts (2335-2345)	46	57	60[1]	54	46	40	36	32	28	23
4. Tafts & Otis (2314-2325)	42	56	58	55	44	38	34	27	26	18
5. Shirley & Triton (2242-2252)	44	57	57[2]	55	45	40	36	32	30	23
6. Siren & Triton (2250-2309)	43	56	59	51	45	40	34	28	30	22
7. Harbor View (2216-2227)	50	55	60	55	46	45	40	36	35	32

NOTES:

[1] Diesels audible, 70 dB peak.
[2] Perhaps, just audible.
Weather conditions: Wind SW very Light.

Appendix B

APPENDIX B

STATISTICAL AMBIENT SOUND LEVELS
POINT SHIRLEY, WINTHROP, MA

Statistical Ambient Sound Levels
Position 1: Engineer's House
Point Shirley, Winthrop, MA

DATE (1986)	TIME	dBA L10	dBA L50	dBA L90
01-Sep	17	63.5	56.5	51.5
01-Sep	18	63.0	56.5	51.5
01-Sep	19	62.5	56.5	51.0
01-Sep	20	62.0	55.0	50.0
01-Sep	21	66.0	58.0	50.5
01-Sep	22	66.0	51.0	46.5
01-Sep	23	59.0	47.5	44.5
01-Sep	24	52.0	44.0	42.5
02-Sep	1	54.0	45.5	42.5
02-Sep	2	48.5	42.5	40.5
02-Sep	3	52.5	42.0	39.0
02-Sep	4	53.0	41.5	38.0
02-Sep	5	51.5	43.0	37.0
02-Sep	6	58.0	44.0	39.0
02-Sep	7	76.5	62.0	47.0
02-Sep	8	70.5	52.0	46.5
02-Sep	9	71.5	54.0	48.5
02-Sep	10	72.0	53.0	48.0
02-Sep	11	72.0	50.0	45.5
02-Sep	12	71.5	51.5	46.5
02-Sep	13	73.5	52.0	47.0
02-Sep	14	67.5	50.0	47.0
02-Sep	15	72.0	50.0	46.0
02-Sep	16	70.5	50.0	44.7
02-Sep	17	73.0	49.0	43.0
02-Sep	18	74.0	51.5	44.0
02-Sep	19	70.0	50.0	45.5
02-Sep	20	70.5	49.0	46.0
02-Sep	21	74.0	51.5	47.5
02-Sep	22	73.0	51.0	46.5
02-Sep	23	71.5	48.5	46.0
02-Sep	24	49.0	46.5	45.5

Statistical Ambient Sound Levels
Position 1: Engineer's House
Point Shirley, Winthrop, MA
(continued)

	DATE (1986)	TIME	-----dBA----- L10	L50	L90
03-Sep	1	47.5	45.5	44.5	
	03-Sep	2	46.0	44.5	43.5
	03-Sep	3	45.0	44.0	43.0
	03-Sep	4	44.5	43.0	42.0
	03-Sep	5	44.0	42.5	41.5
	03-Sep	6	58.5	45.0	42.5
	03-Sep	7	76.5	55.0	45.5
	03-Sep	8	74.0	53.5	46.0
	03-Sep	9	75.0	55.5	46.5
	03-Sep	10	66.5	48.5	45.5
	03-Sep	11	73.0	51.0	45.5
	03-Sep	12	73.0	50.0	44.0
	03-Sep	13	77.5	54.5	46.0
	03-Sep	14	68.5	47.5	44.0
	03-Sep	15	77.5	51.5	44.5
	03-Sep	16	73.0	52.0	44.5
	03-Sep	17	77.5	54.0	44.0
	03-Sep	18	77.5	55.0	45.0
	03-Sep	19	77.5	58.0	45.5
	03-Sep	20	71.0	49.0	44.0
	03-Sep	21	73.5	52.0	43.5
	03-Sep	22	70.5	45.5	42.0
	03-Sep	23	58.0	42.5	39.5
	03-Sep	24	47.0	40.0	38.0
	04-Sep	1	47.0	39.0	37.5
	04-Sep	2	43.0	37.5	36.0
	04-Sep	3	42.5	36.0	35.0
	04-Sep	4	39.0	36.5	36.0
	04-Sep	5	45.0	42.0	39.0
	04-Sep	6	54.0	46.5	43.5
	04-Sep	7	61.0	55.0	48.5

Statistical Ambient Sound Levels
Position 1: Engineer's House
Point Shirley, Winthrop, MA
(continued)

DATE (1986)	TIME	dBA L10	dBA L50	dBA L90
04-Sep	8	61.0	54.0	48.5
04-Sep	9	62.0	54.0	49.0
04-Sep	10	61.5	52.5	47.5
04-Sep	11	74.5	59.5	41.0
04-Sep	12	74.5	60.0	52.5
04-Sep	13	74.0	56.0	51.5
04-Sep	14			
04-Sep	15	73.0	58.0	52.0
04-Sep	16	71.5	54.0	50.0
04-Sep	17	62.0	56.0	51.0
04-Sep	18	61.0	56.0	50.5
04-Sep	19	62.0	53.5	48.5
04-Sep	20	60.5	53.0	48.0
04-Sep	21	60.5	52.0	46.5
04-Sep	22	61.0	51.0	47.0
04-Sep	23	57.0	47.5	45.0
04-Sep	24	52.0	45.5	44.0
05-Sep	1	54.0	46.5	45.0
05-Sep	2	48.5	44.5	43.0
05-Sep	3	48.0	45.5	44.0
05-Sep	4	51.5	47.5	43.0
05-Sep	5	51.5	47.0	44.0
05-Sep	6	59.0	52.5	48.5
05-Sep	7	65.0	58.5	53.0
05-Sep	8	65.0	58.5	53.0
05-Sep	9	64.0	57.5	53.0
05-Sep	10	62.0	57.0	52.5
05-Sep	11	67.5	59.0	53.5
05-Sep	12	75.0	59.0	51.5
05-Sep	13	71.0	56.0	53.0
05-Sep	14	64.5	57.0	52.0

Statistical Ambient Sound Levels
Position 1: Engineer's House
Point Shirley, Winthrop, MA
(continued)

DATE (1986)	TIME	dBA L10	dBA L50	dBA L90
05-Sep	15	62.5	55.5	52.0
05-Sep	16	63.5	57.0	51.5
05-Sep	17	62.0	56.5	51.0
05-Sep	18	62.0	55.5	49.0
05-Sep	19	61.5	55.5	49.5
05-Sep	20	63.0	56.0	47.0
05-Sep	21	63.0	54.5	48.5
05-Sep	22	59.5	49.5	46.5
05-Sep	23	53.5	45.5	43.0
05-Sep	24	44.5	42.5	42.0
06-Sep	1	44.0	42.0	41.0
06-Sep	2	44.5	42.5	41.5
06-Sep	3	44.0	42.0	40.5
06-Sep	4	45.0	42.5	41.0
06-Sep	5	47.5	43.0	41.5
06-Sep	6	56.5	49.0	46.0
06-Sep	7	62.0	53.0	46.0
06-Sep	8	61.5	53.5	42.5
06-Sep	9	62.0	53.0	45.0
06-Sep	10	61.5	55.5	50.0
06-Sep	11	69.0	58.0	51.0
06-Sep	12	74.0	58.0	53.0
06-Sep	13	68.0	57.0	53.0
06-Sep	14	70.0	57.5	53.0
06-Sep	15	71.0	59.5	55.5
06-Sep	16	74.0	59.5	54.5
06-Sep	17	63.0	57.0	51.5
06-Sep	18	61.0	54.5	49.0
06-Sep	19	61.5	54.5	49.0
06-Sep	20	60.0	53.5	46.0
06-Sep	21	60.0	52.5	46.0

Statistical Ambient Sound Levels
Position 1: Engineer's House
Point Shirley, Winthrop, MA
(continued)

DATE (1986)	TIME	dBA L10	L50	L90
06-Sep	22	62.0	52.0	47.5
06-Sep	23	55.0	48.0	46.5
06-Sep	24	50.0	48.0	46.5
07-Sep	1	50.0	48.5	47.0
07-Sep	2	49.5	47.5	47.0
07-Sep	3	50.0	47.0	45.0
07-Sep	4	48.0	47.0	46.0
07-Sep	5	50.5	47.5	46.5
07-Sep	6	67.5	53.5	49.5
07-Sep	7	70.5	61.5	55.0
07-Sep	8	63.0	56.5	50.0
07-Sep	9	64.5	58.0	51.0
07-Sep	10	61.0	53.0	47.0
07-Sep	11	61.5	54.0	47.0
07-Sep	12	60.0	53.0	47.0
07-Sep	13	60.0	51.5	46.5
07-Sep	14	60.0	52.0	47.5
07-Sep	15	59.0	52.5	48.5
07-Sep	16	61.0	55.0	49.5
07-Sep	17	60.0	54.0	48.0
07-Sep	18	62.5	57.0	50.5
07-Sep	19	59.5	53.5	48.0
07-Sep	20	65.0	54.0	46.5
07-Sep	21	66.5	56.0	46.5
07-Sep	22	68.5	57.5	48.5
07-Sep	23	59.5	50.5	48.0
07-Sep	24	55.5	48.5	46.0
08-Sep	1	58.0	47.0	45.0
08-Sep	2	50.5	46.0	44.5
08-Sep	3	50.0	47.5	45.5
08-Sep	4	48.0	45.5	44.0

Statistical Ambient Sound Levels
Position 1: Engineer's House
Point Shirley, Winthrop, MA
(continued)

DATE (1986)	TIME	dBA L10	L50	L90
08-Sep	5	53.5	48.0	46.0
08-Sep	6	62.5	54.5	51.0
08-Sep	7	68.0	60.5	55.5
08-Sep	8	66.5	59.5	53.5
08-Sep	9	67.5	60.5	53.0
08-Sep	10	63.0	52.5	46.0
08-Sep	11	62.0	56.0	48.5
08-Sep	12	64.5	56.5	50.5
08-Sep	13	61.0	54.5	49.5
08-Sep	14	62.5	55.5	51.0
08-Sep	15	62.0	55.0	50.5
08-Sep	16	63.0	56.0	51.0
08-Sep	17	63.5	56.5	51.0
08-Sep	18	65.6	56.5	52.5
08-Sep	19	65.0	58.5	53.0
08-Sep	20	65.0	58.5	52.0
08-Sep	21	67.0	56.5	49.0
08-Sep	22	66.0	56.5	51.0
08-Sep	23	61.0	50.0	48.5
08-Sep	24	53.0	51.0	49.0
09-Sep	1	62.5	51.5	49.5
09-Sep	2	53.0	49.5	47.5
09-Sep	3	49.0	47.0	45.5
09-Sep	4	49.0	47.0	46.0
09-Sep	5	51.5	47.5	46.5
09-Sep	6	64.0	54.5	51.5
09-Sep	7	67.5	61.5	55.0
09-Sep	8	66.5	60.0	56.0
09-Sep	9	65.0	58.5	54.5
09-Sep	10	60.5	53.5	49.0
09-Sep	11	61.0	54.5	50.0

Statistical Ambient Sound Levels
Position 1: Engineer's House
Point Shirley, Winthrop, MA
(continued)

DATE (1986)	TIME	dBA L10	dBA L50	dBA L90
09-Sep	12	61.5	55.5	52.0
09-Sep	13	59.5	54.5	51.0
09-Sep	14	60.0	54.5	52.0
09-Sep	15	61.5	56.0	53.0
09-Sep	16	63.0	58.5	56.0
09-Sep	17	64.0	60.0	57.5
09-Sep	18	63.5	60.0	58.0
09-Sep	19	64.0	58.5	56.0
09-Sep	20	63.5	57.0	54.0
09-Sep	21	65.0	55.0	51.5
09-Sep	22	67.0	51.5	49.0
09-Sep	23	56.0	51.5	49.5
09-Sep	24	56.0	54.5	53.0
10-Sep	1	58.5	57.0	55.5
10-Sep	2	58.5	57.0	56.0
10-Sep	3	58.5	57.0	55.0
10-Sep	4	58.0	56.0	55.0
10-Sep	5	58.0	56.0	54.5
10-Sep	6	62.5	56.5	55.0
10-Sep	7	65.0	59.5	56.5
10-Sep	8	64.5	59.5	57.5
10-Sep	9	64.0	59.0	56.5
10-Sep	10	62.0	57.0	55.5
10-Sep	11	62.5	59.0	56.0
10-Sep	12	63.0	60.0	59.0
10-Sep	13	63.0	60.5	59.0
10-Sep	14	64.0	62.0	60.0
10-Sep	15	63.5	60.5	58.5
10-Sep	16	64.0	60.5	58.5
10-Sep	17	64.0	60.5	58.0
10-Sep	18	64.5	60.5	58.0

Statistical Ambient Sound Levels
Position 1: Engineer's House
Point Shirley, Winthrop, MA
(continued)

DATE (1986)	TIME	dBA L10	dBA L50	dBA L90
10-Sep	19	64.5	60.0	57.5
10-Sep	20	64.5	58.5	56.0
10-Sep	21	65.0	58.5	56.0
10-Sep	22	63.0	56.5	54.0
10-Sep	23	59.0	54.0	52.0
10-Sep	24	57.5	56.0	54.5
11-Sep	1	59.0	58.0	56.5
11-Sep	2	58.5	57.5	56.5
11-Sep	3	59.5	58.0	57.0
11-Sep	4	58.0	57.0	56.0
11-Sep	5	58.5	57.0	55.5
11-Sep	6	61.0	56.5	54.5
11-Sep	7	64.5	60.5	58.0
11-Sep	8	65.0	61.0	59.5
11-Sep	9	65.0	61.0	59.5
11-Sep	10	63.5	60.0	58.0
11-Sep	11	64.0	60.0	57.5
11-Sep	12	63.5	58.5	56.5
11-Sep	13	64.5	60.0	58.0
11-Sep	14	62.5	59.5	58.0
11-Sep	15	63.0	59.0	57.0
11-Sep	16	63.5	59.0	56.5
11-Sep	17	64.0	58.0	55.0
11-Sep	18	64.0	58.5	56.0
11-Sep	19	68.0	60.0	56.0
11-Sep	20	65.0	58.0	53.5
11-Sep	21	66.0	60.0	54.5
11-Sep	22	65.5	59.5	53.0
11-Sep	23	64.5	55.0	51.5
11-Sep	24	56.5	52.5	51.5
12-Sep	1	57.0	54.0	52.5

Statistical Ambient Sound Levels
Position 1: Engineer's House
Point Shirley, Winthrop, MA
(continued)

DATE (1986)	TIME	dBA L10	L50	L90
12-Sep	2	53.0	51.5	50.5
12-Sep	3	52.0	51.0	50.0
12-Sep	4	53.0	51.5	50.5
12-Sep	5	52.0	50.0	47.5
12-Sep	6	67.0	51.5	47.5
12-Sep	7	77.0	62.0	54.5
12-Sep	8	74.0	60.0	50.0
12-Sep	9	72.0	60.0	54.0
12-Sep	10	67.5	56.0	50.0
12-Sep	11	74.0	58.5	51.0
12-Sep	12	76.0	59.0	50.0
12-Sep	13	67.0	55.0	50.0
12-Sep	14	70.5	56.5	50.5
12-Sep	15	70.5	57.5	53.0
12-Sep	16	63.5	57.0	53.0
12-Sep	17	62.5	56.5	52.5
12-Sep	18	63.5	57.0	52.5
12-Sep	19	63.0	56.0	51.0
12-Sep	20	65.0	57.0	50.5
12-Sep	21	64.0	55.0	53.0
12-Sep	22	59.5	55.5	54.0
12-Sep	23	57.0	54.0	51.5
12-Sep	24	51.0	49.5	49.0
13-Sep	1	51.0	48.5	47.0
13-Sep	2	49.5	45.5	42.0
13-Sep	3	43.0	41.0	39.0
13-Sep	4	47.0	41.5	39.5
13-Sep	5	48.5	46.5	45.5
13-Sep	6	64.0	48.0	45.5
13-Sep	7	70.5	56.5	49.0
13-Sep	8	71.5	57.0	47.0

Statistical Ambient Sound Levels
Position 1: Engineer's House
Point Shirley, Winthrop, MA
(continued)

DATE (1986)	TIME	dBA L10	dBA L50	dBA L90
13-Sep	9	73.0	57.0	51.0
13-Sep	10	67.5	54.5	49.5
13-Sep	11	73.5	59.0	51.0
14-Sep	12	71.0	59.5	52.5
14-Sep	13	62.5	55.5	51.5
14-Sep	14	64.5	58.0	51.5
14-Sep	15	60.5	53.5	48.5
14-Sep	16	61.5	54.0	47.0
14-Sep	17	62.5	55.0	46.5
14-Sep	18	61.0	53.5	46.0
14-Sep	19	62.5	54.5	47.5
14-Sep	20	62.5	52.5	45.0
14-Sep	21	60.5	51.5	42.0
14-Sep	22	60.5	50.0	42.5
14-Sep	23	56.5	45.5	40.0
14-Sep	24	52.5	41.0	39.5
15-Sep	1	47.0	44.0	42.0
15-Sep	2	43.0	41.5	40.0
15-Sep	3	56.5	46.5	42.0
15-Sep	4	54.5	48.5	43.5
15-Sep	5	88.5	52.5	45.0
15-Sep	6	76.0	57.5	46.0
15-Sep	7	82.0	62.0	54.0
15-Sep	8	82.0	63.5	52.5
15-Sep	9	71.0	60.0	51.5
15-Sep	10	69.5	58.5	51.5
15-Sep	11	70.0	59.5	53.0
15-Sep	12	70.0	60.5	53.0
15-Sep	13	71.5	59.0	52.0
15-Sep	14	68.0	59.0	52.5
15-Sep	15	72.5	62.0	54.5

Statistical Ambient Sound Levels
Position 1: Engineer's House
Point Shirley, Winthrop, MA
(continued)

DATE (1986)	TIME	dBA L10	dBA L50	dBA L90
15-Sep	16	71.5	61.5	55.0
15-Sep	17	73.0	62.5	56.5
15-Sep	18	72.0	61.0	55.0
15-Sep	19	72.5	60.0	54.5
15-Sep	20	67.0	57.0	50.5
15-Sep	21	66.0	56.0	49.5
15-Sep	22	55.0	54.5	49.5
15-Sep	23	59.0	52.0	49.0
15-Sep	24	56.5	50.0	47.5
16-Sep	1	53.5	49.0	46.5
16-Sep	2	55.0	49.0	46.5
16-Sep	3	49.5	44.5	43.0
16-Sep	4	48.0	45.0	43.5
16-Sep	5	47.5	45.0	44.0
16-Sep	6	65.0	51.0	46.5
16-Sep	7	69.5	57.5	50.5
16-Sep	8	68.5	57.5	50.0
16-Sep	9	68.0	56.5	49.0
16-Sep	10	62.0	54.5	44.0
16-Sep	11	65.0	55.0	45.5
16-Sep	12	65.5	53.5	45.0
16-Sep	13	61.5	49.0	43.5
16-Sep	14	69.5	48.5	44.5
16-Sep	15	72.0	50.0	44.5
16-Sep	16	74.0	53.0	47.5
16-Sep	17	77.0	55.5	47.0
16-Sep	18	78.0	56.0	50.0
16-Sep	19	76.5	53.5	48.0
16-Sep	20	56.5	48.0	44.0
16-Sep	21	60.5	50.0	43.0
16-Sep	22	59.0	48.0	42.0

Statistical Ambient Sound Levels
Position 1: Engineer's House
Point Shirley, Winthrop, MA
(continued)

DATE (1986)	TIME	dBA L10	dBA L50	dBA L90
16-Sep	23	57.0	43.5	41.0
16-Sep	24	46.5	41.5	40.0
17-Sep	1	48.5	40.0	38.5
17-Sep	2	48.0	44.0	39.0
17-Sep	3	43.0	39.5	38.5
17-Sep	4	41.5	39.5	38.5
17-Sep	5	51.5	44.5	39.5
17-Sep	6	62.0	50.0	44.0
17-Sep	7	64.5	59.0	53.5
17-Sep	8	64.5	59.0	54.0
17-Sep	9	62.5	56.0	50.5
17-Sep	10	60.0	54.0	48.5
17-Sep	11	61.0	54.0	47.5
17-Sep	12	61.0	54.0	49.0
17-Sep	13	58.5	52.0	47.0
17-Sep	14	58.5	52.0	48.5
17-Sep	15	59.5	53.0	50.0
17-Sep	16	59.0	53.0	50.0
17-Sep	17	61.5	54.5	50.5
17-Sep	18	62.0	55.0	49.5
17-Sep	19	62.0	55.5	51.0
17-Sep	20	61.0	55.5	50.0
17-Sep	21	62.5	53.5	48.5
17-Sep	22	62.0	52.0	45.0
17-Sep	23	56.5	48.0	44.5
17-Sep	24	56.5	47.5	42.5
18-Sep	1	51.0	47.5	44.0
18-Sep	2	49.5	47.5	46.5
18-Sep	3	48.5	47.5	46.0
18-Sep	4	52.0	49.0	43.5
18-Sep	5	50.5	46.0	42.5

Statistical Ambient Sound Levels
Position 1: Engineer's House
Point Shirley, Winthrop, MA
(continued)

DATE (1986)	TIME	dBA L10	dBA L50	dBA L90
18-Sep	6	59.5	49.5	45.0
18-Sep	7	63.5	57.0	50.5
18-Sep	8	64.0	57.0	51.5
18-Sep	9	61.5	54.5	48.0
18-Sep	10	60.0	50.0	45.0
18-Sep	11	62.0	54.0	46.0

Appendix C

APPENDIX C

LETTER FROM VALERIE A. TALMAGE,
MASSACHUSETTS HISTORICAL COMMISSION,
TO MICHAEL DELAND, U.S. EPA,
DECEMBER 6, 1985

The Commonwealth of Massachusetts
Office of the Secretary of State
Michael Joseph Connolly, Secretary

Massachusetts Historical Commission
Valerie A. Talmage
Executive Director
State Historic Preservation Officer

December 6, 1985

Mr. Michael Deland
Regional Administrator
Environmental Protection Agency
JFK Building
Boston, MA 02203

RE: Harbor Island Treatment Plant

Dear Mr. Deland:

Staff of the MHC have reviewed the historic and architectural survey of Deer Island prepared for the Massachusetts Water Resources Authority by CDM and Boston Affiliates.

In review of this material, we find that the Deer Island Pump Station Complex appears to meet National Register Criteria A and C.

The Pumping Station meets criteria A and C,
1) as a substantially intact sewage pumping complex illustrating the development of the Metropolitan District Commission, one of the earliest major environmental management agencies in the country, and of the City of Boston and its surrounding area, which experienced substantial growth at the turn of the century and
2) as an architecturally distinguished pair of buildings in the Romanesque Revival and Queen Anne styles. The pumping station, built between 1894-99, is notable for it high quality design and materials while the adjoining farmhouse is a particularly good example of Queen Anne/Shingle Style architecture.

We further found that the Deer Island prison complex does not meet National Register of Historic Places Criteria, but that several components individually meet NR criteria.

While individual components of the Prison Complex do retain integrity to their period of significance, the complex as a whole does not, having been altered through the construction of numerous small utility buildings in the 1940s, 1950s, and 1960s and through the demolition or substantial alteration of original elements and significant later structures, such

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as the ca. 1830 House of Industry and the Pauper Boy's School.

Components considered to retain integrity to their period of significance and to meet National Register criteria A and C on the local level are the following:

Hill Prison (1902-04) - Classical Revival building retaining significant elements of its design; significant for its associations with the development of institutional controls in the city of Boston; as an illustration of the continued usage of the Harbor Islands as the historic location of undesirable social institutions (Boston's institutional fringe) and architecturally as a good example of turn-of-the-century institutional design and practice, reflecting current philosophies regarding criminal justice and social reform.

The Superintendants Office (ca. 1910) is an excellent example of Georgian Revival architecture in a good state of preservation. Historically, the office reflects the importance and high status of the Superintendant in its prominent siting and imposing design.

This evaluation of resources in the impact area has been undertaken to assist your agency in compliance with 36 CFR 800, the Advisory Council Regulations.

If you should have any questions, please contact Joseph R. Orfant, Brona Simon or Sarah Zimmerman of the MHC staff.

Sincerely,

Valerie Talmage

Valerie A. Talmage
Executive Director
State Historic Preservation Officer
Massachusetts Historical Commission

cc: M. Hodgson, MWRA
S. Rafferty, CDM
S. Moss, Boston Affiliates
Boston Landmarks Commission

VAT/dr

Appendix D

APPENDIX D

ARCHAEOLOGICAL DOCUMENTARY RESEARCH

UNDERTAKEN BY

PUBLIC ARCHAEOLOGY LABORATORY, INC.

ARCHAEOLOGICAL DOCUMENTARY RESEARCH UNDERTAKEN BY PUBLIC ARCHAEOLOGY LABORATORY, INC.

Institutions like those on Deer Island have long and complex histories, particularly when the operation of such facilities has shifted between various city departments or from city to state or federal agencies or jurisdiction. Of primary importance to this research were documents of the different City of Boston boards of directors, committees and departments which have controlled the numerous Deer Island institutions during the past 140 years. Included among these were Annual Reports of the Public Institutions and Penal Institutions departments, the Houses of Industry, Reformation and Correction, the Overseers of the Poor, the Harbor Master and the City Auditor. The documents were located in the Massachusetts State Library and provided much valuable information.

Unfortunately, although daily and weekly reports of the immediate supervisors of the institutions (including specific information concerning inmates admitted and discharged, physical examinations, visitors to the institutions, and log books of the Houses of Industry and Correction) were located, they were not readily accessible. Many of these documents, some 318 volumes, discovered in the old prison building following a fire, were only sketchily inventoried by Dr. Dennis P. Ryan and Mr. Earl Hamilton in 1985 prior to their transfer to the library at Boston College for preservation and cataloging (Penal Department Communication 1985). Cataloging and indexing of the collection has not yet been completed. Dr. Ryan, who has looked through much of the material, could not remember seeing listings of deaths or burial locations nor information on cemeteries (Dr. Ryan, personal communication, 1987). Mr. Hamilton provided information concerning a "Death Book" maintained at Deer Island. However, as yet, permission has not been received to visit the island and consult this potentially valuable resource.

In addition to the consultation of city documents, the records of the U.S. Army Corps of Engineers at the National Archives and Records Administration Center in Waltham, Massachusetts were examined. The numerous memos, letters and documents relating to the purchase of the military reservation on the southern portion of the island for harbor defense and the subsequent transaction between city and military officials, provided detailed information on the old City of Boston Cemetery located on the military reservation.

Letters were mailed and/or phone calls made to individuals and departments concerned with or knowledgeable about Deer Island. Among those contacted were Captain Swanson of the Metropolitan District Commission, Earl Hamilton of the Penal Institutions Department, Superintendent Broderick and Mrs. Bondar at the Suffolk County House of Correction on Deer Island, the Cemetery Division of the Parks and Recreation Department, Death Section of the City Clerks Department, and Dr. Dennis P. Ryan, a historian of the Boston Irish and consultant to Burns Library at Boston College.

In addition to these primary sources of data, secondary sources on Boston history, Irish immigration, and other related issues were consulted. These sources provided much of the historical background necessary to understand the public institutions established on Deer Island and the inmates who occupied them.

Working within these constraints, this research has focused on the issue of death and burial at the Deer Island institutions to trace the origins and history of the cemeteries on the island. Historical background on the development of the various public institutions is provided to complete and complement this research goal.

Public Institutions on Deer Island

During the 140 years since the City of Boston took possession of Deer Island in 1847 for "sanitary purposes", the island has served as a repository for individuals and a location for institutions considered undesirable within the core urban area.

More than 25,000 alien passengers, many of them Irish immigrants, arrived in Boston during 1847 (Abbott 1926:589). The numbers of ill and dying arriving in Boston were so great that, during the summer of 1847, a receiving room was constructed at Long Wharf in which these invalids could wait for transportation to hospitals. That year, a quarantine hospital was established on Deer Island for the express purpose of receiving alien passengers "as a precautionary measure to ward off a pestilence that would have been ruinous to the public health and business of the city" (Massachusetts Senate Doc. 46, 1848:10).

Large numbers of these immigrants who were sent to Deer Island never recovered. Of 4,816 persons admitted between the opening of the hospital in June, 1847 and January 1, 1850, 4,069 were sick when admitted and 759 died on the island (Abbott 1926).

In 1849, the City of Boston confirmed its earlier decision to use Deer Island as "the place of quarantine for the Port of Boston" (City Doc. 27, 1849:5). All ships entering Boston Harbor containing passengers or cargo considered to be "foul and infected with any malignant or contagious disease" were required to anchor at Deer Island until such time as the Port Physician gave permission to leave following removal of passengers and cleaning and purification of the vessel (City Doc. 27, 1849:6).

Prior to 1849, the city maintained only one institution on Deer Island, a quarantine station and hospital for immigrants and paupers unable to care for themselves, located on the southern half of the island. Beginning in that year, most of the Deer Island facilities were "occupied as an appendage to the South Boston establishment" of the House of Industry (City Doc. 25, 1849:4). As of March 31, 1849, the Deer Island Department of the House of Industry had 396 inmates. The hospital continued at Deer Island until 1866 when it was replaced by a new hospital on Gallop's Island (Mikal 1973:50).

A brick building was completed in 1852 to house the Deer Island Almshouse and House of Industry located on the northern half of the island. While these two institutions were considered

separately in much of the official documentation, a major problem on the island was the close association of the two categories of inmates. The Almshouse was established to serve the virtuous or deserving poor, and these individuals were permitted to live at Deer Island when they were unable to support and care for themselves. Facilities provided for the Almshouse population included a nursery, schools, hospital (shared with other institutions), housing, and workshops.

The inmates of the House of Industry were sentenced by the courts to serve time at Deer Island for misdemeanors and crimes committed in the City, including large numbers of individuals sentenced for drunkenness and idleness. This second category of inmates, the sentenced or vicious poor, were seen as a bad influence on the Almshouse population and on the children within the institution (City Doc. 27, 1857:7; City Doc. 25, 1860:5). However, it was not until construction of additional facilities to relieve overcrowding during the latter half of the nineteenth century that a more or less total separation of the two groups of inmates was accomplished. Meanwhile, the population of those institutionalized grew quickly from the 331 recorded in 1856 to 1,746 inmates in the combined institutions in 1886.

In addition, as early as 1854, Deer Island was being considered for the location of a new House of Correction. In that year the Committee on Public Buildings authorized a portion of the brick building, then housing the Almshouse and House of Industry, to be remodeled by the addition of cells, for use as a prison facility (City Doc. 24, 1856:3). As a result, inmates of the building were redistributed among the other structures on the island, most of them "inadequate and incommodious" (city Doc. 27, 1857:6). In November of 1858, the building was completed and the city poor in the House of Industry were moved into it from the wooden buildings. At this time a portion of the building was also allocated for the use of the House of Reformation. No prisoners from the House of Correction were yet sent to the island.

During the summer of 1858, the House for the Employment and Reformation of Juvenile Offenders-Boys was transferred from South Boston to new quarters at Deer Island. Boys sentenced for misdemeanors such as truancy, larceny and idleness were sent here for discipline (Snow 1971:156). Shortly thereafter, in the fall, a school for girls was established in the House of Industry and became known as the House of Reformation-Girls. Between 1866 and 1873 neglected children were transferred to the Almhouse facilities (Bradlee 1976:9-12). Also present on the island at this time, to serve the needs of children, were the Pauper Boys and Pauper Girls Schools within the Almshouse, serving the deserving poor. Until 1869/1870, the children were housed with the men and women of the institutions. After that date, with construction of new facilities, boys and girls were not only separated from each other, but also from the adults.

The year 1877 saw a number of changes in the population and institutions at Deer Island. Adult female paupers were removed to Austin Farm. The pauper and neglected boys were removed to the Marcella Street Home in Roxbury. This helped to relieve the crowded conditions at the main building. The only paupers remaining at Deer Island Almshouse following this reorganization were the young children in the nursery, pauper girls, and a few adult females too ill to be transferred with the rest (City Doc. 49, 1877:18).

In 1882, a House of Correction was established at Deer Island with the transfer of some inmates from the House of Correction in South Boston. Young men were sent to Concord Reformatory, the rest went to Deer Island. The House of Correction was not considered a reformatory, but "merely a place of punishment and detention" (City Doc. 9, 1887:34). Men were employed in many occupations on the island, i.e., farming, stone cutting, and manufacturing a number of items.

In Chapter 536, Section 9, of the Acts of 1896, the institution formerly known as the House of Industry on Deer Island "was established as a Suffolk County Institution, and designated as the House of Correction at Deer Island" (City Doc. 14, 1897:1). A new cell building was completed about this time, providing 500 additional cells. It was not until 1902 that the last of the inmates housed in the House of Correction in South Boston were moved to Deer Island and the consolidation completed. After this date the House of Correction was the only City of Boston institution located on Deer Island. All other inmates in the Almshouse and schools had been moved to other locations.

In 1906, following negotiations between the City of Boston and the U.S. Government, the City deeded nearly 100 acres in the southern portion of Deer Island to the federal government for the construction of a military reservation and harbor defenses (Suffolk Co. Registry Book 3177:577). Included in the stipulations of this transfer was the agreement that the City would build a boundary wall between City and military reservation property, remove the old piggery and other City property, discontinue cultivation and removal of sand, gravel and sod, and discontinue burials in old Resthaven Cemetery on the new military reservation property (U.S. Army Corps of Engineers).

A sewage treatment plant was constructed on the island in 1889 with a major outlet into the harbor built at the south end of the island. In the 1950's some 39 acres of land adjacent to the prison facilities on the south end were taken by the Metropolitan District Commission for an "antipollution and sewer project" (City Doc. 17, 1957:3). The resulting sewage treatment plant was completed in 1968.

Documents of the City of Boston indicate that through time Deer Island has become the final resting place for large numbers of individuals. During the forced occupation of Deer Island by "friendly" or "Christian" Indians during King Phillip's War in 1675, many of the Native Americans died. As they were not allowed to leave the island, burial of the dead presumably took place on Deer Island. Sweetser (1883:195) stated that of "500 martyrs to English distrust very many died, and were sadly buried by the moaning and misty sea." The locations of such burials was not recorded and is unknown. No evidence of Native American burials has been recovered from archaeological surveys on the island.

Prior and subsequent to King Phillip's War, Deer Island was leased by the City of Boston to a number of individuals or families (Snow 1971:199-203). The records do not provide any details regarding deaths or interments on the island by any of these tenants. None of the early maps of Deer Island indicate locations of burials or cemeteries.

Since 1847, when the City of Boston took possession of Deer Island "for sanitary purposes", the

island has been the home of various public institutions for the care of both adult and juvenile ill, poor homeless, and sentenced offenders as described above. As such, it has also been the site of many deaths and subsequent burials of the unclaimed dead. It is on the burials and cemeteries associated with the institutions that this research focused in the effort to determine the dates, identities, methods of burial, and institutional affiliations of the interments in the new cemetery.

The initial years of the Quarantine Hospital and Almshouse at Deer Island was the period of the major influx of Irish immigrants fleeing the potato famine and disease in Ireland. Between 1847, when the institutions were established, and the end of 1849, some 4,816 persons had been admitted. Of this total number, 4,069 were ill upon their arrival at Deer Island and 759 died on the island (Abbott 1926:598). Some 721 individuals were buried on Deer Island during the years 1847-1849. These interments appear to have been made in the old Resthaven Cemetery, located on the southern portion of the island, later owned by the U.S. government (U.S. Army Corps of Engineers 1908). The discrepancy between the number of deaths and the number of burials most likely indicates that some bodies were claimed by family or friends for burial elsewhere, while only the unclaimed or indigent were buried at city expense on the island.

From the initially large numbers in 1847 to 1854, deaths and burials on the island declined sharply between 1854 and 1855 along with the drop in immigration to Boston. The number of burials remained low through the Civil War years, increasing in the mid 1870's. The reason for this increase remains unclear, although general economic conditions were bad, possibly leading to greater numbers of poor being sent to the Almshouse and House of Industry.

Deaths and burials on the island decreased with slight fluctuations through the end of the nineteenth century. This reduction in the number of deaths and burials on Deer Island can probably be linked to improved sanitray conditions and health care as well as to the change in the composition of the institutionalized population. Prior to 1896, persons residing at Deer Island institutions were a varied group of men, women and children, many of whom had been living in exteme poverty conditions and were in poor physical condition, if not ill, upon their arrival. After 1896, the population at Deer Island was primarily composed of inmates in the House of Correction who had been sentenced for crimes committed, but had not necessarily been poor or ill before their arrival. In general, this latter population was healthier than those who had preceded them on Deer Island.

The records available, primarily Annual Reports of the various city committees and departments in charge of the institutions on Deer Island, provide little information about the manner in which deaths, funerals and burial were handled on the island. Even the reports of the chaplains at the institutions fail to mention deaths or burials. Only one chaplain's report was noted which mentioned that "funeral and baptismal rites have been attended to when called upon" (City Doc. 14, 1897:51).

Burial on Deer Island was referred to indirectly in several annual reports mentioning construction activities related to burials and cemeteries. In the "Annual Report of the Directors of the House of Industry and Reformation, for the Year 1856-1857" construction of new tombs was reported:

> The Tombs, originally located on the north easterly face of the Island, being found unsuited to their purposes, from their exposure to flooding by the action of the sea in severe storms, have been discontinued; and the material used in the construction of new ones in a more secure and suitable position. (City Doc. 40, 1857:4)

Construction of the new tombs was in an undisclosed location. In addition, during the same year, labor was expended in "digging graves for reception and depositing the bodies removed from City of Boston" (City Doc. 40, 1857:21). There is no explanation provided about how many graves were dug or where and why these bodies were removed from Boston for burial on the island.

A morgue was built on Deer Island in 1886 for the use of the various institutions as needed. The annual report for that year refers to the morgue as:

> A neat and appropriate house ... for temporary deposit of the bodies of those who may die, with room for showing the bodies to friends, and where funeral services can be performed when they are not removed for burial in other grounds (City Doc. 9, 1887:38)

Where bodies were buried if unclaimed and not removed from the island was not mentioned in the report. The first mention found in city documents and annual reports of the presence of a cemetery on Deer Island came in the 1909 "Annual Report of the Penal Institutions Department." This report, which post dates the sale of the southern portion of Deer Island from the City of Boston to the U.S. Government, makes reference to city compliance with one of the stipulations in the deed of transfer.

> Owing to the taking of the land from the institution by the United States Government the creation of a new cemetery and receiving tomb were made necessary, and these have been completed. All the bodies in the old cemetery have been carefully transferred. (City Doc. 29, 1909:8).

The old cemetery referred to is "Resthaven (City of Boston) Cemetery at Deer Island" located on the military reservation property, southeast of the gate through the concrete boundary wall separating the City and Federal property on the southern end of the island.

A document and letter on file in the U.S. Army Corps of Engineers records provides information about Resthaven located from City records in 1908 (U.S. Corps of Engineers, 1908).

> [Captain Fredendall] secured from the City of Boston the records showing the number of bodies interred therein and dates thereof, which show that this cemetery has been used for the burial of all immigrants dying at the quarantine station or brought in from ships from 1847 to 1882, since which date it has been used for burial of criminals dying at the penal institutions, City of Boston, not claimed by relatives or friends.

Fredendall's letter further indicates that in 1908 Resthaven Cemetery contained 4,160 bodies "interred in lots of eight or ten in trenches."

If "all the bodies" in the old Resthaven Cemetery were removed to the new cemetery, presumably to the cemetery on the northeast hill behind the prison and between the piggery and the boundary wall, this new cemetery would have contained 4,160 bodies as of its creation in 1908. Subsequent deaths and burials of institution inmates would have added somewhat to that number.

Unfortunately, conflicting evidence exists in the U.S. Army Corps. of Engineers records suggesting that only the eighteen bodies deposited in old Resthaven Cemetery in 1908, after the final sale of the property, were transferred to the new northeast cemetery. This is substantiated by a letter from the Master of the Suffolk County House of Correction on Deer Island dated December 30, 1908. Master Cronin reported that the 18 bodies in question, those placed in Resthaven subsequent to the sale, had been removed (U.S. Army Corps of Engineers 1908). His letter does not indicate that "all the bodies" were transferred as stated in the annual report. This conflicting evidence raises some questions as to the exact number of bodies in the newer northeast cemetery.

A further question relating to this new northeast cemetery concerns how long it was in active use following its creation in 1908. No additional mention of its presence or use was noted in subsequent city documents. A 1923 map of the city property on Deer Island, which accompanied a report considering relocating the State Prison to the island, showed all existing and planned structures, but did not indicate the cemetery plot nor the associated receiving tomb. It seems unlikely, though possible, that if the plot was in active use, its existence would be omitted from this planning document. This leaves some doubt as to whether bodies were being buried in the cemetery in 1923. However, the cemetery is indicated in 1946 U.S.G.S. topographic maps and on the current maps.

An interview with Mr. Earl Hamilton of the Penal Institutions Department, and a former Superintendent of the Suffolk County House of Corrections at Deer Island, provided additional evidence concerning the new northeast cemetery (personal interview, 1987). According to Mr. Hamilton, the new northeast cemetery is also called Resthaven, or new Resthaven. He was unsure as to how long it remained in use, but suggested that it was likely that bodies were buried there until the road was built connecting Deer Island with Winthrop after the U.S. Army Corps of Engineers filled Shirley Gut in 1933/1934.

Current practice on the island with regards to deceased prisoners is to call a Boston mortuary to pick up the body. Following an autopsy the death is logged in the prison death book and the body is either turned over to relatives or, if unclaimed, is buried in a City pauper cemetery such as Mt. Hope Cemetery (Hamilton, personal interview, 1987).

In 1970, when Mr. Hamilton began working at Deer Island, the new northeast cemetery or new Resthaven was marked by some 30 to 40 white wooden crosses in poor repair. A photograph in Mr. Hamilton's posession, dated to 1929, shows the cemetery in the upper center as a large area stretching between the piggery to the boundary wall and tightly filled with white wooden crosses (Figure 6.3.1-1, page 6-68). Judging by this photo it appears likely that indeed all 4,160 bodies from old Resthaven had been transferred and reinterred in the new Resthaven cemetery above the Hill Prison Building. In addition, Mr. Hamilton knew of no reason to believe that these bodies had been removed from the island since the picture was taken.

Sometime prior to the 1970's, the practice of sending details of prisoners to paint the crosses and maintain the cemetery had ceased. The condition of the cemetery had been allowed to deteriorate until it was barely acknowledgeable as a cemetery in 1985.

The primary goal in this research has been to discover as much information as possible relating to the new cemetery noted in the 1985 archaeological reconnaissance survey and located on the northeast slope behind the Hill Prison building. Three hypotheses concerning this cemetery were developed and tested using the data collected.

Hypothesis I concerned the possibility that the new northeast cemetery contained only bodies of inmates of the House of Correction who died since the closing of old Resthaven Cemetery after the sale of the southern portion of Deer Island to the U.S. military. In this case, few bodies would be expected; only those bodies unclaimed between 1907-1908 and the present.

Hypothesis II was similar to the first hypothesis, but indicated that the eighteen bodies buried in the old cemetery on the island during or since the sale to the U.S. Government may have been reinterred in the new cemetery along with unclaimed bodies buried in the years since the property transfer.

Hypothesis III suggested that, upon the sale of the southern portion of Deer Island, all 4160 city interments in old Resthaven were removed to the new cemetery closer to the prison facilities. This hypothesis also took into account the probability that subsequent bodies may have been added.

During the course of the in-depth documentary research, contradictory evidence was uncovered concerning the origins and development of the new northeast cemetery. No data was recovered which supported Hypothesis I. The only mentions made of the new cemetery also referred to reinterments. Evidence collected from the U.S. Army Corps of Engineers documents tended to support Hypothesis II, suggesting that 18 bodies had been transferred from old Resthaven Cemetery and reinterred in the new northeast cemetery. City documents, though containing little information pertaining to burials at all, indicated that "all the bodies in the old cemetery" were reinterred in the new plot (City Doc. 29, 1909:8).

It now appears most likely that Hypothesis III is correct, that the cemetery in question is "New Resthaven Cemetery" created in 1908 with the reinterment of some 4,160 bodies from old Resthaven Cemetery in the military reservation on the southern portion of Deer Island. The cemetery, at its present location, is 79 years old, or greater than 50 years of age, which requires additional archaeological investigations in accordance with NHPA. In addition, 2,559 of the bodies reinterred in new Resthaven are 100 years of age or older, many of them having been quarantine hospital victims and Irish immigrants. Additional unclaimed bodies were probably buried in the plot at least through the early 1930's when Shirley Gut was finally filled and Deer Island was connected by road to Winthrop.

What this research has revealed is that the new northeast cemetery plot, or new Resthaven, is much larger than expected from the cursory field inspection of the site. Judging by the 1929 photo shown in Figure 6.3.1-2, the cemetery extended from the northeast wall of the old piggery

to the cement boundary and wall from the sea wall at the top of the slope to the mausoleum at the foot of the slope. The many wood scraps originally thought to be picket fence remains and, therefore, assumed as markers of the plots' boundary, were more likely remnants of the wooden crosses which were once maintained to mark the graves in the tightly packed cemetery. As no evidence has been found suggesting the removal of these burials to another location, it is expected that some 4,160 to 4,500 bodies remain interred in the new cemetery. The only evidence for the plan of burials within the new cemetery is the 1929 photo. It suggests that either individual graves were located very close together or that individual crosses marked bodies buried in trenches. The latter possibility seems most probable for the reinterments due to the age and likely condition of the earlier burials when transferred from old Resthaven Cemetery, where evidence indicates the bodies were buried eight to ten per trench.

Additional archaeological testing was undertaken in May 1987. The results will be included in the final report. Two methods of remote sensing techniques, soil resistivity and electron magnetometry, have been used to attempt to discern any patterns of disturbance that may be present in the area of the historic period cemetery and could possibly signify burials. Experience with soil resistivity testing at several historic period cemeteries ranging in age from the late seventeenth to nineteenth centuries has indicated that more recent burials have greater resistivity. A soil resistivity survey of the Deer Island cemetery to identify the probable location of burials prior to any actual subsurface testing. Electron magnetometry works in a similar manner and has been used as a second verification method. The results of the soil resistivity and electron magnetometry surveys have been used to develop a map or plan of the location of soil anomalies. This map was subsequently used in consultation with the Massachusetts Historical Commission, to plan an effective subsurface testing or burial verification program for the cemetery.

The primary objectives or tasks for the recommended fieldwork have included: (1) determination of the horizontal extent of the cemetery through systematic subsurface testing; and (2) collection of sufficient data to reconstruct the internal configuration or plan of the cemetery and general mode of burial (individual graves, multiple burials in trench, etc.) used at this site.

Actual subsurface testing within the known cemetery is being performed in July, 1987, to verify the existence of burials. This fieldwork involves the use of both machine assisted and hand excavation techniques. A small backhoe or similar machine will be used to excavate a series of narrow trenches through the cemetery to expose the upper surface of filled grave shafts. Machine excavated trenches could be oriented in several ways within the cemetery area. Subsurface anomalies located by soil resistivity testing that represent potential unmarked burials could be tested with judgementally oriented trenches placed on the locations of these anomalies. Other deliberately placed trenches will be necesary to identify the horizontal limits of the cemetery if it is found to actually contain unmarked burials. Given the moderately sloping surface of the cemetery, the machine excavated trenches will probably have to be oriented perpendicular to the natural slope, since it would be unlikely that a backhoe or similar equipment could operate across this slope. These trenches will be excavated with machinery (small backhoe or front-end loader) only to a depth suficient to identify a filled grave/burial shaft. Once a definitive grave shaft or fill has been identified, hand excavation

will be used to complete the investigation. Excavation with hand tools would proceed only until the presence of human skeletal remains can be verified within an identified grave or burial. Once human skeletal remains have been positively identified they will be left in situ and the State Archaeologist will be notified.

Representative soil profiles will be recorded from all machine excavated trenches and scaled drawings made of profiles exposed during the excavation of specific burials. The locations of trenches excavated during the archaeological investigation and any burials identified during the survey will also be mapped. All aspects of the archaeological investigation will be recorded in documentary photographs (color, black/white). This would include photographing any burials located and positively identified during fieldwork. The final report summarizing the results of the archaeological testing will be included in the Treatment Plant EIR/EID, Volume III.

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Appendix E

APPENDIX E

TRAFFIC IMPACT ANALYSIS METHODOLOGY

This appendix describes the existing Winthrop traffic environment, the impacts of construction transport operation, and the analysis method used in evaluating the impacts.

EXISTING TRAFFIC ENVIRONMENT

Land access to Deer Island is by a causeway that connects the island to the mainland. The island is within the corporate boundary of Boston; however, access to the causeway is by local roads passing through the town of Winthrop.

Figure E-1 is a location map of Winthrop. Route 145 does not pass through the central part of town, where the downtown business district and town hall are located, but rather circumnavigates it. The route provides general access from the north and west, over Bennington Street, Saratoga Street, Main Street, Pleasant Street, Washington Avenue, Veterans Road, Winthrop Shore Drive, Crest Avenue and Revere Street. One the western side, the crossing of Belle Isle Inlet leads to East Boston. On the northern side, a similar crossing leads to the town of Revere.

Figure E-1 is also a street map of Winthrop. A truck route has been defined and is posted, requiring that truck movements into and out of Winthrop and to Deer Island and back, use Bennington Street, Saratoga Street, Main Street, Revere Street, Shirley Street, Veterans Road, Washington Avenue, and Shirley Street. This route also avoids passage through the town center. Current truck movements over the defined route often occur with police escort.

Restrictions affecting use of the truck route include load limits on the bridge carrying Saratoga Street over the MBTA Blue Line. The bridge is currently limited to two-axle trucks that are 13 tons or less, three-axle trucks that are 20 tons or less, and five-axle trucks that are 33 tons or less.

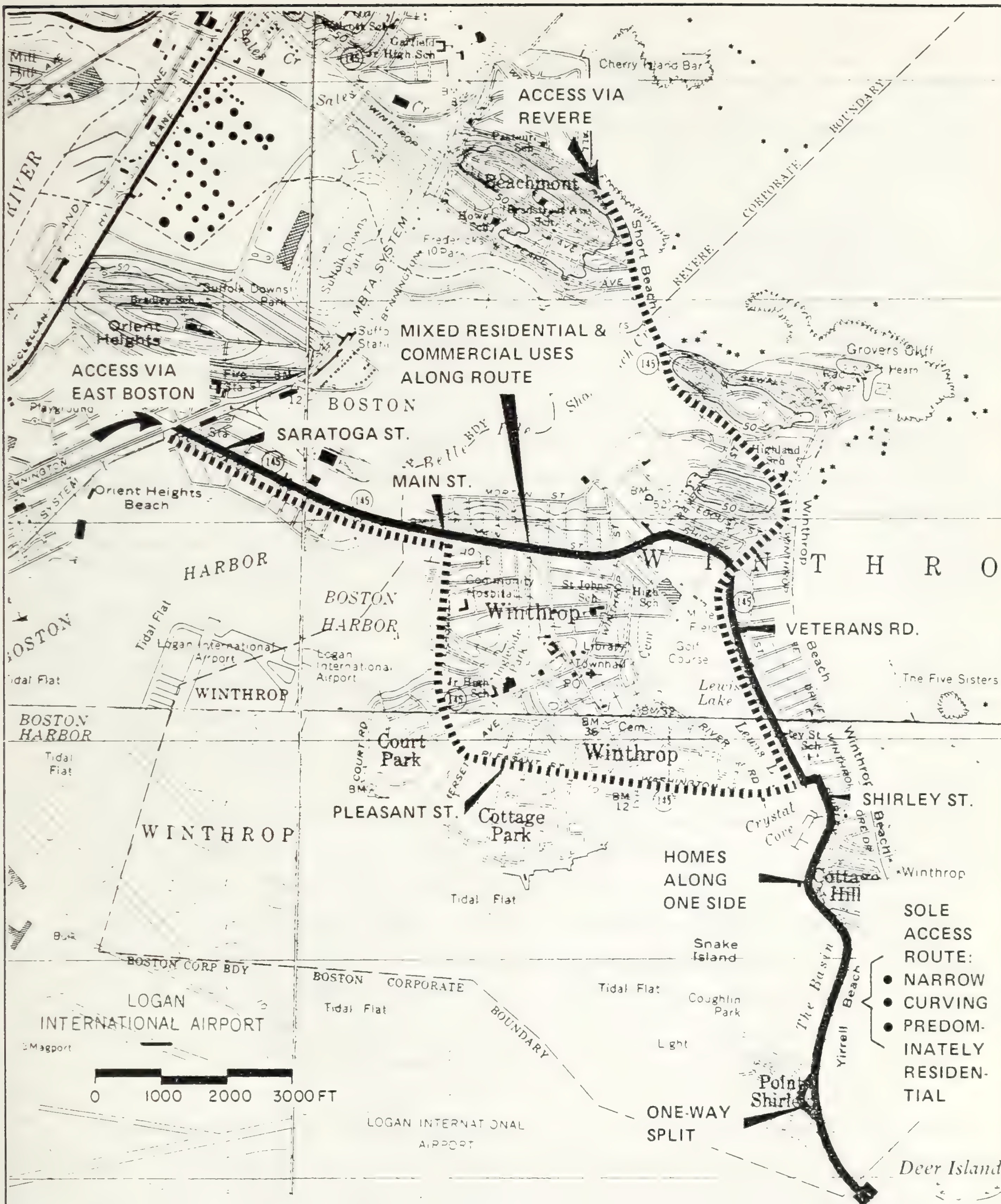

Figure E-1
Access Roadways to Deer Island
(From CE Maguire, 1987)

Curbside parking is allowed along Main Street, Revere Street, Shirley Street, and the lower section of Shirley Street. The entire truck route supports two-way traffic flow; no one-way routing has been used to achieve higher throughput.

Local roadways elsewhere in Winthrop are fairly narrow, and there are no restrictions on curbside parking. Observed vehicular movements are dispersed and irregular. Only rarely is traffic movement delayed while a moving vehicle enters the opposing lane to avoid a parked vehicle occupying the moving lane.

Observations of general traffic conditions in Winthrop have shown that vehicular speeds in Winthrop are between 20 and 30 mph and appear to be a matter of local habit and preference rather than a result of deliberate enforcement policies. Observed speeds over the entire truck route are moderate, serving to reduce congestion and preserve safety along the route.

Eight intersections along the current truck route that would be affected by truck movements to and from Deer Island have been identified. These intersections are:

- Bennington Street and Saratoga Street - phased signal.
- Main Street and Pleasant Street - phased signal.
- Main Street and Hermon Street - phased signal.
- Main Street, Revere Street, Winthrop Street - blinking signal.
- Revere Street and Shirley Street - blinking signal.
- Shirley Street and Veterans Road - blinking Signal.
- Veterans Road and Washington Avenue - no signal.
- Washington Avenue and Shirley Street - no signal.

An alternative truck route has also been identified for use in support of Deer Island construction activities. Use of the alternative truck route would avoid the axle load restrictions of the Belle Isle Inlet bridge crossing and possible problems posed by curbside parking along Main Street, Revere Street, and the upper portion of Shirley Street.

The alternative truck route would have vehicles bound for Deer Island enter and leave Winthrop over the northern portion of Route 145. The specific local streets to be used would be Revere Street, Crest Avenue, Winthrop Shore Drive, Veterans Road, Washington Avenue, and Shirley Street to Deer Island. This route is more direct and requires less penetration of established residential and commercial development in Winthrop. It also has the advantage of relatively wider street cartways and fewer heavily used intersections than the truck route now being used.

Using the alternative route, trucks could gain access to major arterials north of Winthrop in Revere while avoiding the Belle Isle Inlet bridge. The route would take trucks leaving Winthrop north on Route 145 to a rotary that accesses the Revere Beach Parkway (Route 16) going south.

Trucks must currently exit the parkway onto Route 1A because a portion of Winthrop Shore Drive between Routes 16 and 1A is restricted by a bridge that limits trucks to weights of 3 tons or less. Instead, trucks could take 1A north through a rotary to the Revere Beach Parkway (Route 16) south and thus access major throughroads while bypassing the congested Sumner Tunnel and the restrictions of the two previously mentioned bridges. Figure E-1 shows the truck route.

One difficulty with the alternative route is that the Route 145 connection to Ocean Avenue in Revere is not completely open to trucks. The last 0.7 mile providing access to the Revere Beach rotary is currently closed to trucks. The route may not be used by trucks unless this restriction is mitigated.

For the above reason, some of the earlier transportation assessments have suggested that truck movements be turned at the southern limits of this restricted section onto Winthrop Avenue in Revere, for movement to Bennington Street at the Beachmont Station of the MBTA Blue Line. This solution is not considered desirable because Winthrop Avenue traverses a densely settled residential area with narrow cartways, curbside parking, steep gradients, and indirect access to Bennington Street at the west end because of one-way traffic routing.

Five intersections in Winthrop along the proposed alternative truck route would be affected by truck movements to and from the Deer Island construction site. These are:

- Crest Avenue and Revere Street - blinking signal
- Veterans Road and Winthrop Shore Drive - no signal
- Veterans Road and Shirley Street - blinking signal
- Veterans Road and Washington Avenue - no signal*
- Washington Avenue and Veterans Road - no signal*

* Intersection is also included in the existing truck route.

Observations of the affected ten intersections in Winthrop showed that significant queues do not develop, with the exception of the two intersections along Main Street that have phased signal control. These were at Hermon Street and Pleasant Street. Elsewhere, queues of no more than six vehicles are the rule, and all of these rapidly clear the intersection crossings.

During peak periods, queues accumulated at the approach stop lines were dissipated within the available green intervals in all cases except one. The left turn out of Pleasant Street onto Main Street westbound did not clear in the morning peak 20 minutes.

Peak conditions have a very short duration in Winthrop. Observations have shown that the peak hour in the morning can reasonably be identified as between 6:30 and 7:30 a.m.; however, peak conditions really exist only during the 20 minutes between 6:50 and 7:10 a.m. The same is true in the afternoon. The peak hour lasts from 5:00 to 6:00 p.m., although truly peak conditions extend over only 20 minutes between 5:20 and 5:40 p.m.

METHOD OF ANALYSIS

The volume of traffic that can pass over a given roadway is largely a function of the speed at which traffic moves. Given normal driver reaction,

speeds decline as traffic volume increases; maximum throughput usually occurs at speeds ranging from 30 to 40 mph.

Determinants of capacity vary for different types of facilities. In general, freeway capacity is a function of lane width, number of lanes provided, availability of improved shoulders and sight lines. For arterials, capabilities at intersections where conflicting movements can occur are usually the determinant of capacity; this is especially true in heavily travelled corridors. Under principles of analysis established through the work of the Highway Research Board, the maximum volume that occurs under the conditions described above is generally taken as representing the capacity of the particular facility under examination.

The potential impact on particular intersections in Winthrop that will be affected most directly by the Deer Island construction traffic has been examined in detail, to determine whether new intersection delay could cause significant local distress. The purpose in these detailed assessments has been to identify potential changes of service level at the intersections and delay associated with queues awaiting a green signal.

To measure the performance of existing or proposed highway facilities, the ratio of projected volume to available capacity is commonly used. The numerator and the denominator of this ratio are usually measured in terms of hourly vehicular flows, and a value of unity for the ratio is accepted as an indication that traffic volume fills the available capacity of a facility. Ratios larger than unity imply traffic volume in excess of available capacity, moving under forced flow conditions at slow speed. A ratio having a value less than unity means that volume has not yet reached capacity and the more acceptable traffic conditions prevail.

Because of the need for recognition of local traffic conditions in estimates of highway performance, the Highway Research Board in 1965 adopted a defined series of Service Levels that could be used in comparative assessments of the degree to which highway facilities accommodate traffic. These Levels of Service have had wide acceptance and application since 1965.

The Highway Research Board Levels of Service represent qualitative standards of the overall ability of defined highway facilities to satisfy motorists' desires at different times of the day and in relation to various levels of average operating speed, safety, freedom of maneuver, traffic mix, and operating cost. Standard Levels of Service have been defined for limited-access facilities and for urban and rural arterials. The requirements for the several Levels of Service give recognition to the number of lanes available for travel, degree of intersection interference, lane width, and other aspects of highway geometry and control.

In general, the defined Levels of Service A, B, and C described traffic volumes that are sufficiently low to provide free and stable flow of traffic at attractive operating speeds. Service Level D usually describes a volume for given facilities that would cause unstable flow conditions to be approached, at reduced and less attractive operating speeds. Service Levels E and F usually connote excessive volumes, unstable or forced flow conditions, high levels of delay, and unattractive operating speeds.

Work has been done in recent years to relate delay at intersections to the relationship between traffic volume and available capacity, and in turn to levels of service. The relationships developed in this work have been used in the present investigations.

Computer-based methods of analysis have been used, allowing specific consideration of the magnitude and composition of traffic flows from each approach entering an intersection. Specific 15-minute peaking relationships are recognized for each approach, and an independent assessment is made of the degree to which each approach operates with the available green time at the signal fully used to pass traffic. Estimates of capacity, the ratio of volume to capacity, service level, delay, and length of queue have been prepared for each approach at each intersection and for each intersection as a whole.

Through iterative application of the program to existing conditions and to conditions that will exist with the new plant in operation, the differential

impact that will be experienced at each location as a result of the change in truck flows has been identified.

The methods used in the analysis are completely consistent with American traffic engineering practice. The details for method and data applied in each case are set forth in a description of the investigations performed for each intersection that appears later in this report.

The intersections have all been analyzed using phased signal control. In the proposed conditions, phased signalling is used as a safety measure to mitigate the estimated increase in traffic flow. In the existing condition analyses, phased signaling is used in all cases to provide a baseline for comparison with the projections made for the future.

INTERSECTION ASSESSMENTS - WINTHROP, MA

Intersection traffic volumes and turning movements were estimated whenever possible using existing traffic count data. Turning movement count data collected during previous studies for the morning and afternoon peak periods showed that the critical hour in Winthrop occurs in the afternoon peak period. Turning movement counts were available for six of the intersections; additional counts were made for the remaining four intersections. Signal phasing and intersection geometry data were obtained from the Massachusetts Department of Public Works and the Town of Winthrop.

The following computed estimates have been made for each intersection:

- Service Level for each intersection approach
- Service Level for the intersection as a whole
- Delay in vehicle-hours for each intersection approach
- Delay in vehicle-hours for the intersection as a whole
- Average queue length for each intersection approach

All estimates have been developed assuming no change of existing cartway widths, curbside parking practice, or signal phasing. In cases where the

intersection is not now controlled by a phased signal, a signal with equal cycle lengths for each leg has been used for purposes of this analysis. Details pertaining to each intersection examined are discussed below.

1) Main and Pleasant Streets - HMM Associates traffic data collected on 11 September 1985 show that the peak hour at this location occurs between 5:00 and 6:00 p.m. The largest peak-hour volumes occur on the eastbound Main Street approach. The total peak-hour volume is 1,757 vehicles; the signal cycle time is 94 seconds.

2) Main, Revere, and Winthrop Streets - HMM Associates traffic data collected on 12 September 1985 show that the peak hour at this location occurs between 5:00 and 6:00 p.m. The largest peak-hour volumes occur on the eastbound Main Street and westbound Revere Street approaches. The total peak-hour volume is 1,386 vehicles; the signal cycle time is 79 seconds.

3) Revere and Shirley Streets - PEER Consultants traffic data collected on 10 July 1987 show that the peak hour at this location occurs between 5:00 and 6:00 p.m. The largest peak-hour volumes occur on the eastbound Revere Street approach. The total peak-hour volume is 1,392 vehicles; the signal cycle time is 68 seconds. This intersection is currently controlled using blinking lights; movements on Revere Street in both directions are controlled by yellow flashers, and movements on Shirley Street are controlled by a red flasher.

4) Shirley Street and Veterans Road - HMM Associates traffic data collected on 11 September 1985 show that the peak hour at this location occurs between 5:00 and 6:00 p.m. The largest peak-hour volumes occur on the eastbound Shirley Street approach. The total peak-hour volume is 605 vehicles; the intersection is currently controlled by a blinker with no provision for phased signaling.

5) Veterans Road and Washington Avenue - HMM Associates traffic data collected on 12 September 1985 show that the peak hour at this location occurs between 5:00 and 6:00 p.m. The largest peak-hour volumes occur on the eastbound and westbound Washington Street approaches. The total peak-hour volume is 796 vehicles; the intersection is currently controlled by a stop sign.

6) Washington Avenue and Shirley Street - HMM Associates traffic data collected on 11 September 1987 show that the peak hour at this location occurs between 5:00 and 6:00 p.m. The largest peak-hour volumes occur on the eastbound Washington Avenue and northbound Shirley Street approaches. The total peak-hour volume is 823 vehicles; the intersection is currently controlled by a stop sign.

7) Veterans Road and Winthrop Shore Drive - PEER Consultants traffic data collected on 8 July 1987 show that the peak hour at this location occurs between 4:30 and 5:30 p.m. The largest peak-hour volumes occur on the southbound Winthrop Shore Drive approach. The total peak-hour volume is 761 vehicles; the intersection is currently uncontrolled.

8) Revere Street, Crest Avenue, and Highland Avenue - PEER Consultants traffic data collected on 9 July 1987 show that the peak hour at this location occurs between 4:45 and 5:45 p.m. The largest peak-hour volumes occur on the southbound Revere Street approach. The total peak-hour volume is 1,592 vehicles; the intersection is currently controlled by a blinking yellow and red flasher with no provision for phased signaling.

9) Bennington Street and Saratoga Avenue - HMM Associates traffic data collected on 1 October 1985 show that the peak hour at this location occurs between 5:00 and 6:00 p.m. The largest peak-hour volumes occur on the northbound Bennington Street and westbound Saratoga Street approaches. The total peak-hour volume is 2,250 vehicles; the signal cycle time is 113 seconds.

Each intersection has been examined under worst-case conditions regarding the need for daily truck movement in support of current operations on Deer Island and proposed construction activities. These conditions have included recognition of all the peak-to-base relationships plus the following:

1) Changes of truck and automobile volume caused by the Deer Island construction activities will occur on particular legs of the intersection.

2) Where the potential exists for truck and automobile movements to involve right or left turns through the intersection, the worst-case movements are used in the analysis.

3) Most truck movements will occur outside commutation peak hours and will be spread throughout the course of the day. The maximum volume of trucks that will move through the intersection during any hour is 24. The 24 trucks correspond to an upper volume limit described earlier in this report. This truck volume has been applied to the peak hour under the assumption that if conditions do not change significantly during this worst-case assumption, normal truck movements will have no affect on the intersection.

4) It is estimated that a maximum of 65 additional automobiles will move through an intersection during the peak hour because of construction activities.

5) Intersections not currently controlled by phased signaling have been analyzed with signal control. Those intersections with the current capability of phased control have been analyzed using the information contained on the phasing permit. Intersections that require installation of phased signals have been analysed using an 80-second signal cycle with the green time equally apportioned among all legs of the intersection.

The intersections have been analyzed for both existing and future service level conditions. The existing condition analysis establishes a baseline for measuring whether additional traffic volumes moving through an intersection will affect current intersection performance.

Table E-1 summarizes the existing condition Service Levels. The table shows the intersection peak traffic volumes, effective capacity, signal cycle time, estimated overall Service Level, and computed average delay for each intersection under existing conditions. In all cases, the Overall Service Level is A.

TABLE E-1

EXISTING CONDITION SERVICE LEVELS

Intersection	Peak-hour volume	Effective capacity	Cycle time (sec)	Overall srvc lvl	Avg delay per vhcl (sec)
Bennington & Saratoga	2,250	4,799	113	A	18
Main & Pleasant	1,757	5,601	94	A	7
Main, Revere, & Winthrop	1,386	2,631	79	A	19
Revere & Shirley	1,392	3,116	68	A	11
Veterans & Shirley	605	3,628	80	A	6
Veterans & Washington	796	4,456	80	A	2
Washington & Shirley	823	3,915	80	A	3
Veterans & Winthrop Shr	761	3,506	80	A	4
Crest, Revere, & Highland	1,592	3,677	80	A	14

Table E-2 summarizes the future condition Service Levels using worst-case condition that all trucks are moving in one direction: toward Deer Island. The table shows the intersection peak traffic volumes, effective capacity, signal cycle time, estimated overall Service Level, and computed average delay for each intersection under existing conditions. In all cases, the overall Service Level is A.

TABLE E-2

FUTURE CONDITION SERVICE LEVELS

TRUCK MOVEMENTS TO DEER ISLAND

Intersection	Peak-hour volume	Effective capacity	Cycle time (sec)	Overall srvc lvl	Avg delay per vhcl (sec)
Bennington & Saratoga	2,273	4,768	113	A	19
Main & Pleasant	1,806	5,539	94	A	7
Main, Revere, & Winthrop	1,474	2,517	79	A	24
Revere & Shirley	1,416	3,023	68	A	11
Veterans & Shirley	629	3,587	80	A	8
Veterans & Washington	820	4,321	80	A	3
Washington & Shirley	848	3,825	80	A	3
Veterans & Winthrop Shr	785	3,429	80	A	5
Crest, Revere, & Highland	1,616	3,650	80	A	14

Table E-3 summarizes the future condition Service Levels using the worst-case condition that all trucks are moving in one direction: away from Deer Island. The table shows the intersection peak traffic volumes, effective capacity, signal cycle time, estimated overall Service Level, and computed average delay for each intersection under existing conditions. In all cases, the overall Service Level is A.

TABLE E-3

FUTURE CONDITION SERVICE LEVELS

TRUCK MOVEMENTS FROM DEER ISLAND

Intersection	Peak-hour volume	Effective capacity	Cycle time (sec)	Overall srvc lvl	Avg delay per vhcl (sec)
Bennington & Saratoga	2,340	4,724	113	A	19
Main & Pleasant	1,845	5,476	94	A	7
Main, Revere, & Winthrop	1,410	2,581	79	A	22
Revere & Shirley	1,480	3,060	68	A	13
Veterans & Shirley	693	3,502	80	A	6
Veterans & Washington	884	4,190	80	A	3
Washington & Shirley	911	3,852	80	A	5
Veterans & Winthrop Shr	849	3,326	80	A	4
Crest, Revere, & Highland	1,704	3,632	80	A	17

The following pages are copies of computer printouts for the Winthrop intersection analysis.

INTERSECTION SERVICE LEVEL ANALYSES

EXISTING CONDITION

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT — 301-04
Selectd-Hour Intersection Performance — 28 JUL 87
FJH

INTERSECTION OF Benninintcn & Saratoga Streets
Current Traffic Volumes: Condition E-2 — EXSTG CNDTN
Current Weekdav Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 — CYCLE TIME 113 SEC
RESIDENTIAL — CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Bennington NB SRL	25.0	50.0	4.0	2.0	1.06	1.0	1.0	2,480
Bennington NB Right	13.0	100.0	0.0	1.0	1.17	0.7	1.0	1,380
Bennington SB SRL	27.0	14.0	35.0	4.0	1.02	0.7	1.0	2,050
Saratoga EB SRL	40.0	4.0	12.0	0.0	1.13	0.7	1.0	4,310
Saratoga WB SRL	22.0	24.0	46.0	2.0	1.10	0.7	1.0	2,520
Saratoga WB Left Sn	22.0	70.0	0.0	2.0	1.10	0.7	1.0	3,150

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Bennington NB SRL	654	0.28	694	0.94	E	36.7	6.7	7
Bennington NB Right	331	0.42	580	0.57	A	15.1	1.4	6
Bennington SB SRL	298	0.28	574	0.52	A	12.8	1.1	3
Saratoga EB SRL	335	0.22	948	0.35	A	6.3	0.6	4
Saratoga WB SRL	316	0.22	554	0.57	A	15.1	1.3	4
Saratoga WB Left Sn	316	0.46	1,449	0.22	A	2.8	0.2	3
INTERSECTION TOTALS	2,250		4,799	0.46	A		11.3	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT
Selectd-Hour Intersection Performance

301-04
28 JUL 87
FJH

INTERSECTION OF Main and Pleasant Streets
Current Traffic Volumes: Condition E-2
Current Weekday Afternoon Peak Hour

EXSTG CNDTN

METROPOLITAN POPULATION 2,900,000
RESIDENTIAL

CYCLE TIME 94 SEC
CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Main EB SRL	28.0	33.0	0.0	0.0	1.18	0.7	1.0	4,590
Main EB Right	14.0	100.0	0.0	0.0	1.21	0.7	1.0	2,390
Main WB SRL	18.0	0.0	4.0	0.0	1.21	0.7	1.0	3,160
Pleasant NB SRL	14.0	12.0	87.0	0.0	1.35	0.7	1.0	1,850
Pleasant SB SRL	12.0	65.0	6.0	0.0	1.88	0.7	1.0	2,510

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Main EB SRL	849	0.48	2,203	0.39	A	7.6	1.8	5
Main EB Right	278	0.31	741	0.38	A	7.3	0.6	5
Main WB SRL	312	0.48	1,517	0.21	A	2.6	0.2	4
Pleasant NB SRL	301	0.44	814	0.37	A	6.9	0.6	4
Pleasant SB SRL	17	0.13	326	0.05	A	0.6	0.0	1
INTERSECTION TOTALS	1,757		5,601	0.31	A		3.2	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT | 301-04
Selectd-Hour Intersection Performance | 28 JUL 87
FJH

INTERSECTION OF Main, Revere, and Winthrop Streets
Current Traffic Volumes; Condition E-2 | EXSTG CNDTN
Current Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 | CYCLE TIME 79 SEC
RESIDENTIAL | CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Main EB SRL	17.0	23.0	0.0	1.0	1.13	1.0	1.0	1,850
Main WB RL	13.0	100.0	0.0	0.0	1.25	0.7	1.0	2,260
Winthrop NB RL	13.0	0.0	100.0	0.0	1.33	0.7	1.0	2,070
Revere SB SRL	18.0	48.0	2.0	1.0	1.22	0.7	1.0	2,750

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Main EB SRL	514	0.33	611	0.84	D	30.2	4.3	8
Main WB RL	70	0.19	429	0.16	A	1.7	0.0	1
Winthrop NB RL	249	0.33	683	0.36	A	6.6	0.5	4
Revere SB SRL	553	0.33	908	0.61	B	17.1	2.6	4
INTERSECTION TOTALS	1,386		2,631	0.52	A		7.4	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT — 301-04
Selectd-Hour Intersection Performance — 28 JUL 87
FJH

INTERSECTION OF Shirley and Revere Streets
Current Traffic Volumes; Condition E-2 — EXSTG CNDT
Current Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 — CYCLE TIME 68 SE
RESIDENTIAL — CLRNC TIME 4 SE

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG
Shirley NB RL	13.0	100.0	0.0	1.0	1.16	0.7	1.0	1,37
Revere EB SR	18.0	14.0	0.0	0.0	1.08	0.7	1.0	2,12
Revere EB Right	9.0	100.0	0.0	0.0	1.21	0.7	1.0	96
Revere WB SL	16.5	0.0	8.0	0.0	1.18	0.7	1.0	2,11

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEU (VEH
Shirley NB RL	172	0.35	480	0.36	A	6.6	0.3	2
Revere EB SR	579	0.53	1,124	0.52	A	12.8	2.1	5
Revere EB Right	82	0.41	394	0.21	A	2.6	0.1	1
Revere WB SL	559	0.53	1,118	0.50	A	11.9	1.8	5
INTERSECTION TOTALS	1,392		3,116	0.44	A		4.3	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT
Selectd-Hour Intersection Performance

301-04
28 JUL 87
FJH

INTERSECTION OF Veterans HWY & Shirley Street
Current Traffic Volumes: Condition E-2
Current Weekday Afternoon Peak Hour

EXSTG CNDTN

METROPOLITAN POPULATION 2,900,000
RESIDENTIAL

CYCLE TIME 80 SEC
CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Shirley EB SRL	12.0	28.0	19.0	1.0	1.14	0.7	1.0	1,270
Shirley WB SRL	13.0	6.0	3.0	0.0	1.22	0.7	1.0	2,620
Veterans NB SRL	16.0	8.0	64.0	7.0	1.24	0.7	1.0	2,040
Veterans SB SRL	16.0	39.0	17.0	5.0	1.31	0.7	1.0	2,130

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Shirley EB SRL	268	0.45	572	0.47	A	10.7	0.8	3
Shirley WB SRL	36	0.45	1,179	0.03	A	0.6	0.0	1
Veterans NB SRL	158	0.45	918	0.17	A	1.9	0.1	2
Veterans SB SRL	143	0.45	959	0.15	A	1.6	0.1	2
INTERSECTION TOTALS	605		3,628	0.16	A		1.0	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT — 301-04
Selectd-Hour Intersection Performance — 28 JUL 87
FJH

INTERSECTION OF Veterans HWY & Washington Avenue
Current Traffic Volumes: Condition E-2 — EXSTG CNDTN
Current Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 — CYCLE TIME 80 SEC
RESIDENTIAL — CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Washington EB SRL	20.0	0.0	10.0	1.0	1.20	0.7	1.0	3,280
Washington WB SRL	26.0	5.0	0.0	2.0	1.15	0.7	1.0	4,350
Veterans SB SRL	22.0	100.0	0.0	3.0	1.23	0.7	1.0	2,270

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Washington EB SRL	387	0.45	1,476	0.26	A	3.7	0.4	5
Washington WB SRL	287	0.45	1,958	0.15	A	1.6	0.1	3
Veterans SB SRL	122	0.45	1,022	0.12	A	1.2	0.0	2
INTERSECTION TOTALS	796		4,456	0.17	A		0.5	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT — 301-04
Selectd-Hour Intersection Performance — 28 JUL 87
FJH

INTERSECTION OF Shirley Street & Washington Avenue
Current Traffic Volumes: Condition S-2 — EXSTG CNDTN
Current Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 — CYCLE TIME 80 SEC
RESIDENTIAL — CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Washington EB SRL	[illegible]	76.0	0.0	1.0	1.19	0.7	1.0	4,240
Shirley NB SRL	24.0	13.0	76.0	1.0	1.12	0.7	1.	2,000
Shirley SB SRL	20.0	61.0	7.0	5.0	1.03	0.7	1.0	2,460

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Washington EB SRL	424	0.45	1,908	0.22	A	2.8	0.3	5
Shirley NB SRL	285	0.45	900	0.32	A	5.3	0.4	3
Shirley SB SRL	114	0.45	1,107	0.10	A	1.0	0.0	1
INTERSECTION TOTALS	823		3,915	0.21	A		0.7	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT — 301-04
Selectd-Hour Intersection Performance — 28 JUL 87
FJH

INTERSECTION OF Veterans Road & Winthrop Shore Drive
Current Traffic Volumes; Condition E-2 — EXSTG CNDTN
Current Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 — CYCLE TIME 80 SEC
RESIDENTIAL — CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Veterans EB RL	13.0	100.0	0.0	1.0	1.17	0.7	1.0	2,120
Winthrop NB SL	20.0	0.0	13.0	0.0	1.03	0.7	1.0	2,840
Winthrop SB SR	20.0	34.0	0.0	0.0	1.06	0.7	1.0	2,830

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Veterans EB RL	82	0.45	954	0.09	A	0.9	0.0	1
Winthrop NB SL	275	0.45	1,278	0.22	A	2.8	0.2	3
Winthrop SB SR	404	0.45	1,274	0.32	A	5.3	0.6	5
INTERSECTION TOTALS	761		3,506	0.21	A		0.8	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT
Selectd-Hour Intersection Performance

301-04
28 JUL 87
FJH

INTERSECTION OF Crest, Highland, and Revere
Current Traffic Volumes: Condition E-2
Current Weekday Afternoon Peak Hour

EXSTG CNDTN

METROPOLITAN POPULATION 2,900,000
RESIDENTIAL

CYCLE TIME 80 SEC
CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Highland WB SRL	13.0	27.0	11.0	0.0	1.13	0.7	1.0	1,600
Crest NB SRL	13.0	1.0	35.0	0.0	1.04	0.7	1.0	1,080
Revere EB SRL	21.0	15.0	62.0	0.0	1.12	0.7	1.0	2,600
Revere SB SRL	21.0	55.0	7.0	0.0	1.11	0.7	1.0	2,890

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Highland WB SRL	81	0.45	720	0.11	A	1.1	0.0	1
Crest NB SRL	272	0.45	486	0.56	A	14.6	1.1	3
Revere EB SRL	420	0.45	1,170	0.36	A	6.6	0.8	5
Revere SB SRL	819	0.45	1,301	0.63	B	18.1	4.1	9
INTERSECTION TOTALS	1,592		3,677	0.43	A		6.0	

INTERSECTION SERVICE LEVEL ANALYSIS

MOVEMENTS TO DEER ISLAND

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT — 301-04
Selectd-Hour Intersection Performance — 28 JUL 87
FJH

INTERSECTION OF Bennininton & Saratoga Streets
Expected Traffic Volumes: Condition F-6 — +24 TO DI
New Plant Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 — CYCLE TIME 113 SEC
RESIDENTIAL — CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Bennington NB SRL	25.0	51.0	4.0	4.0	1.06	1.0	1.0	2,430
Bennington NB Right	13.0	100.0	0.0	4.0	1.17	0.7	1.0	1,340
Bennington SB SRL	27.0	14.0	35.0	4.0	1.02	0.7	1.0	2,050
Saratoga EB SRL	40.0	4.0	12.0	0.0	1.13	0.7	1.0	4,310
Saratoga WB SRL	22.0	24.0	46.0	2.0	1.10	0.7	1.0	2,520
Saratoga WB Left Sn	22.0	70.0	0.0	2.0	1.10	0.7	1.0	3,150

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Bennington NB SRL	666	0.28	680	0.98	E	39.4	7.3	7
Bennington NB Right	342	0.42	563	0.61	B	17.1	1.6	6
Bennington SB SRL	298	0.28	574	0.52	A	12.8	1.1	3
Saratoga EB SRL	335	0.22	948	0.35	A	6.3	0.6	4
Saratoga WB SRL	316	0.22	554	0.57	A	15.1	1.3	4
Saratoga WB Left Sn	316	0.46	1,449	0.22	A	2.8	0.2	3
INTERSECTION TOTALS	2,273		4,768	0.47	A		12.1	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT 301-04
Selectd-Hour Intersection Performance 28 JUL 87
FJH

INTERSECTION OF Main and Pleasant Streets
Expected Traffic Volumes; Condition F-6 +24 TO DI
New Plant Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 CYCLE TIME 94 SEC
RESIDENTIAL CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Main EB SRL	28.0	31.0	0.0	3.0	1.18	0.7	1.0	4,460
Main EB Right	14.0	100.0	0.0	0.0	1.21	0.7	1.0	2,390
Main WB SRL	18.0	0.0	4.0	0.0	1.21	0.7	1.0	3,160
Pleasant NB SRL	14.0	12.0	87.0	0.0	1.35	0.7	1.0	1,850
Pleasant SB SRL	12.0	65.0	6.0	0.0	1.88	0.7	1.0	2,510

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Main EB SRL	898	0.48	2,141	0.42	A	8.7	2.2	6
Main EB Right	278	0.31	741	0.38	A	7.3	0.6	5
Main WB SRL	312	0.48	1,517	0.21	A	2.6	0.2	4
Pleasant NB SRL	301	0.44	814	0.37	A	6.9	0.6	4
Pleasant SB SRL	17	0.13	326	0.05	A	0.6	0.0	1
INTERSECTION TOTALS	1,806		5,539	0.32	A		3.6	

SIGNALLED INTERSECTION ANALYSIS

IRA DEER ISLAND TRFFC IMPACT
electd-Hour Intersection Performance

301-04
28 JUL 87
FJH

NTERSECTION OF Main, Revere, and Winthrop Streets
pected Traffic Volumes; Condition F-6
w Plant Weekday Afternoon Peak Hour

+24 TO DI

ETROPOLITAN POPULATION 2,900,000
ESIDENTIAL

CYCLE TIME 79 SEC
CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
ain EB RL	17.0	100.0	0.0	6.0	1.13	1.0	1.0	1,700
ain WB RL	13.0	100.0	0.0	0.0	1.25	0.7	1.0	2,260
nthrop NB RL	13.0	0.0	100.0	0.0	1.33	0.7	1.0	2,070
evere SB RL	18.0	98.0	2.0	1.0	1.22	0.7	1.0	2,750

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
ain EB RL	538	0.33	561	0.96	E	38.0	5.7	10
ain WB RL	70	0.19	429	0.16	A	1.7	0.0	1
nthrop NB RL	249	0.33	683	0.36	A	6.6	0.5	4
evere SB RL	553	0.33	908	0.61	B	17.1	2.6	4
NTERSECTION TOTALS	1,410		2,581	0.54	A		8.8	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT — 301-04
Selectd-Hour Intersection Performance — 28 JUL 87
FJH

INTERSECTION OF Shirley and Revere Streets
Expected Traffic Volumes; Condition F-6 — +24 TO DI
New Plant Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 — CYCLE TIME 68 SE
RESIDENTIAL — CLRNC TIME 4 SE

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG
Shirley NB RL	13.0	100.0	0.0	1.0	1.16	0.7	1.0	1,37
Revere EB SR	18.0	16.0	0.0	2.0	1.08	0.7	1.0	2,04
Revere EB Right	9.0	100.0	0.0	13.0	1.21	0.7	1.0	84
Revere WB SL	16.5	0.0	8.0	0.0	1.18	0.7	1.0	2,11

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEU (VEH
Shirley NB RL	172	0.35	480	0.36	A	6.6	0.3	2
Revere EB SR	591	0.53	1,081	0.55	A	14.2	2.3	5
Revere EB Right	94	0.41	344	0.27	A	4.0	0.1	1
Revere WB SL	559	0.53	1,118	0.50	A	11.9	1.8	5
INTERSECTION TOTALS	1,416		3,023	0.46	A		4.5	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT — 301-04
Selectd-Hour Intersection Performance — 28 JUL 87
FJH

INTERSECTION OF Veterans HWY & Shirley Street
Expected Traffic Volumes: Condition F-6 — +24 TO DI
New Plant Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 — CYCLE TIME 80 SEC
RESIDENTIAL — CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Shirley EB SRL	12.0	34.0	17.0	10.0	1.14	0.7	1.0	1,18
Shirley WB SRL	13.0	6.0	3.0	0.0	1.22	0.7	1.0	2,62
Veterans NB SRL	16.0	8.0	64.0	7.0	1.24	0.7	1.0	2,04
Veterans SB SRL	16.0	39.0	17.0	5.0	1.31	0.7	1.0	2,13

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEU (VEH
Shirley EB SRL	292	0.45	531	0.55	A	14.2	1.2	3
Shirley WB SRL	36	0.45	1,179	0.03	A	0.6	0.0	1
Veterans NB SRL	158	0.45	918	0.17	A	1.9	0.1	2
Veterans SB SRL	143	0.45	959	0.15	A	1.6	0.1	2
INTERSECTION TOTALS	629		3,587	0.17	A		1.4	

S I G N A L L E D   I N T E R S E C T I O N   A N A L Y S I S

MWRA DEER ISLAND TRFFC IMPACT
Selectd-Hour Intersection Performance

301-04
28 JUL 87
FJH

INTERSECTION OF Veterans HWY & Washington Avenue
Expected Traffic Volumes: Condition F-6
New Plant Weekday Afternoon Peak Hour

+24 TO DI

METROPOLITAN POPULATION 2,900,000
RESIDENTIAL

CYCLE TIME 80 SEC
CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Washington EB SRL	20.0	0.0	10.0	1.0	1.20	0.7	1.0	3,28[illegible]
Washington WB SRL	36.0	5.0	0.0	2.0	1.15	0.7	1.0	4,35[illegible]
Veterans SB SRL	22.0	100.0	0.0	19.0	1.27	0.7	1.0	1,97[illegible]

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Washington EB SRL	387	0.45	1,476	0.26	A	3.7	0.4	5
Washington WB SRL	287	0.45	1,958	0.15	A	1.6	0.1	3
Veterans SB SRL	146	0.45	887	0.16	A	1.7	0.1	2
INTERSECTION TOTALS	820		4,321	0.18	A		0.6	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT — 301-04
Selectd-Hour Intersection Performance — 28 JUL 87
FJH

INTERSECTION OF Shirley Street & Washington Avenue
Expected Traffic Volumes; Condition F-6 — +24 TO DI
New Plant Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 — CYCLE TIME 80 SEC
RESIDENTIAL — CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Washington EB SRL	26.0	77.0	0.0	6.0	1.19	0.7	1.0	4,040
Shirley NB SRL	24.0	13.0	76.0	1.0	1.12	0.7	1.0	2,000
Shirley SB SRL	20.0	61.0	7.0	5.0	1.03	0.7	1.0	2,460

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Washington EB SRL	449	0.45	1,818	0.25	A	3.5	0.4	5
Shirley NB SRL	285	0.45	900	0.32	A	5.3	0.4	3
Shirley SB SRL	114	0.45	1,107	0.10	A	1.0	0.0	1
INTERSECTION TOTALS	848		3,825	0.22	A		0.8	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT — 301-04
Selectd-Hour Intersection Performance — 28 JUL 87
FJH

INTERSECTION OF Veterans Road & Winthrop Shore Drive
Expected Traffic Volumes; Condition F-6 — +24 TO DI
New Plant Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 — CYCLE TIME 80 SEC
RESIDENTIAL — CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Veterans EB RL	13.0	100.0	0.0	1.0	1.17	0.7	1.0	2,120
Winthrop NB SL	20.0	0.0	13.0	0.0	1.03	0.7	1.0	2,840
Winthrop SB SR	20.0	38.0	0.0	6.0	1.06	0.7	1.0	2,660

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Veterans EB RL	82	0.45	954	0.09	A	0.9	0.0	1
Winthrop NB SL	275	0.45	1,278	0.22	A	2.8	0.2	3
Winthrop SB SR	428	0.45	1,197	0.36	A	6.6	0.8	5
INTERSECTION TOTALS	785		3,429	0.22	A		1.0	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT — 301-04
Selectd-Hour Intersection Performance — 28 JUL 87
FJH

INTERSECTION OF Crest, Highland, and Revere
Expected Traffic Volumes; Condition F-2 — +24 TO DI
Do-Nothing Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 — CYCLE TIME 80 SEC
RESIDENTIAL — CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Highland WB SRL	13.0	27.0	11.0	0.0	1.13	0.7	1.0	1,600
Crest NB SRL	13.0	1.0	35.0	0.0	1.04	0.7	1.0	1,080
Revere EB SRL	21.0	15.0	62.0	0.0	1.12	0.7	1.0	2,600
Revere SB SRL	21.0	53.0	6.0	3.0	1.11	0.7	1.0	2,830

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Highland WB SRL	81	0.45	720	0.11	A	1.1	0.0	1
Crest NB SRL	272	0.45	486	0.56	A	14.6	1.1	3
Revere EB SRL	420	0.45	1,170	0.36	A	6.6	0.8	5
Revere SB SRL	843	0.45	1,274	0.66	B	19.7	4.6	10
INTERSECTION TOTALS	1,616		3,650	0.44	A		6.5	

INTERSECTION SERVICE LEVEL ANALYSES

MOVEMENTS FROM DEER ISLAND

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT — 301-04
Selectd-Hour Intersection Performance — 28 JUL 87
FJH

INTERSECTION OF Bennington & Saratoga Streets
Expected Traffic Volumes: Condition F-6 — +88 FROM DI
New Plant Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 — CYCLE TIME 113 SEC
RESIDENTIAL — CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Bennington NB SRL	25.0	50.0	4.0	2.0	1.06	1.0	1.0	2,480
Bennington NB Right	13.0	100.0	0.0	1.0	1.17	0.7	1.0	1,380
Bennington SB SRL	27.0	14.0	35.0	4.0	1.02	0.7	1.0	2,050
Saratoga EB SRL	40.0	4.0	12.0	0.0	1.13	0.7	1.0	4,310
Saratoga WB SRL	22.0	21.0	48.0	5.0	1.08	0.7	1.0	2,450
Saratoga WB Left Sn	22.0	69.0	0.0	5.0	1.08	0.7	1.0	3,020

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Bennington NB SRL	654	0.28	694	0.94	E	36.7	6.7	7
Bennington NB Right	331	0.42	580	0.57	A	15.1	1.4	6
Bennington SB SRL	298	0.28	574	0.52	A	12.8	1.1	3
Saratoga EB SRL	335	0.22	948	0.35	A	6.3	0.6	4
Saratoga WB SRL	361	0.22	539	0.67	B	20.2	2.0	4
Saratoga WB Left Sn	361	0.46	1,389	0.26	A	3.7	0.4	3
INTERSECTION TOTALS	2,340		4,724	0.49	A		12.2	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT
Selectd-Hour Intersection Performance

301-04
28 JUL 87
FJH

INTERSECTION OF Main and Pleasant Streets
Expected Traffic Volumes: Condition F-6
New Plant Weekday Afternoon Peak Hour

+88 FROM DI

METROPOLITAN POPULATION 2,900,000
RESIDENTIAL

CYCLE TIME 94 SEC
CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Main EB SRL	28.0	33.0	0.0	0.0	1.18	0.7	1.0	4,590
Main EB Right	14.0	100.0	0.0	0.0	1.21	0.7	1.0	2,390
Main WB SRL	18.0	0.0	4.0	6.0	1.17	0.7	1.0	2,900
Pleasant NB SRL	14.0	12.0	87.0	0.0	1.35	0.7	1.0	1,850
Pleasant SB SRL	12.0	65.0	6.0	0.0	1.88	0.7	1.0	2,510

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Main EB SRL	849	0.48	2,203	0.39	A	7.6	1.8	5
Main EB Right	278	0.31	741	0.38	A	7.3	0.6	5
Main WB SRL	400	0.48	1,392	0.29	A	4.5	0.5	5
Pleasant NB SRL	301	0.44	814	0.37	A	6.9	0.6	4
Pleasant SB SRL	17	0.13	326	0.05	A	0.6	0.0	1
INTERSECTION TOTALS	1,845		5,476	0.33	A		3.5	

SIGNALLED INTERSECTION ANALYSIS

WRA DEER ISLAND TRFFC IMPACT — 301-04
electd-Hour Intersection Performance — 28 JUL 87
FJH

NTERSECTION OF Main, Revere, and Winthrop Streets
xpected Traffic Volumes; Condition F-6 — +88 FROM DI
ew Plant Weekday Afternoon Peak Hour

ETROPOLITAN POPULATION 2,900,000 — CYCLE TIME 79 SEC
ESIDENTIAL — CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
in EB RL	17.0	100.0	0.0	1.0	1.13	1.0	1.0	1,780
ain WB RL	13.0	100.0	0.0	0.0	1.25	0.7	1.0	2,260
inthrop NB RL	13.0	0.0	100.0	0.0	1.33	0.7	1.0	2,070
evere SB SRL	18.0	42.0	2.0	4.0	1.11	0.7	1.0	2,480

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
ain EB RL	514	0.33	587	0.88	D	32.7	4.7	8
ain WB RL	70	0.19	429	0.16	A	1.7	0.0	1
inthrop NB RL	249	0.33	683	0.36	A	6.6	0.5	4
evere SB SRL	641	0.33	918	0.78	C	26.5	4.7	5
NTERSECTION TOTALS	1,474		2,517	0.58	A		9.9	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT 301-04
Selectd-Hour Intersection Performance 29 JUL 87
FJH

INTERSECTION OF Shirley and Revere Streets
Expected Traffic Volumes; Condition F-6 +86 FROM D
New Plant Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 CYCLE TIME 63 SE
RESIDENTIAL CLRNC TIME 4 SE

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG
Shirley NB RL	13.0	100.0	0.0	10.0	1.11	0.7	1.0	1,21
Revere EB SR	18.0	14.0	0.0	0.0	1.08	0.7	1.0	2,12
Revere EB Right	9.0	100.0	0.0	0.0	1.21	0.7	1.0	96
Revere WB SL	16.5	0.0	8.0	0.0	1.18	0.7	1.0	2,11

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEU (VEH
Shirley NB RL	260	0.35	424	0.61	B	17.1	1.2	3
Revere EB SR	579	0.53	1,124	0.52	A	12.8	2.1	5
Revere EB Right	82	0.41	394	0.21	A	2.6	0.1	1
Revere WB SL	559	0.53	1,118	0.50	A	11.9	1.8	5
INTERSECTION TOTALS	1,480		3,060	0.48	A		5.2	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT | I01-04
Selectd-Hour Intersection Performance | 28 JUL 87
FJH

INTERSECTION OF Veterans HWY & Shirley Street
Expected Traffic Volumes: Condition F-6 | +88 FROM DI
New Plant Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 | CYCLE TIME 80 SEC
RESIDENTIAL | CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Shirley EB SRL	12.0	28.0	19.0	1.0	1.14	0.7	1.0	1.270
Shirley WB SRL	13.0	6.0	3.0	0.0	1.22	0.7	1.0	2.630
Veterans NB SRL	16.0	5.0	77.0	14.0	1.11	0.7	1.0	1,760
Veterans SB SRL	16.0	39.0	17.0	5.0	1.31	0.7	1.0	2.130

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Shirley EB SRL	268	0.45	572	0.47	A	10.7	0.8	3
Shirley WB SRL	36	0.45	1,179	0.03	A	0.6	0.0	1
Veterans NB SRL	246	0.45	792	0.31	A	5.1	0.3	3
Veterans SB SRL	143	0.45	959	0.15	A	1.6	0.1	2
INTERSECTION TOTALS	693		3,502	0.19	A		1.2	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT — 301-04
Selectd-Hour Intersection Performance — 28 JUL 87
FJH

INTERSECTION OF Veterans HWY & Washington Avenue
Expected Traffic Volumes: Condition F-6 — +88 FROM DI
New Plant Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 — CYCLE TIME 80 SEC
RESIDENTIAL — CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Washington EB SRL	[illegible]	0.0	10.0	1.0	1.20	0.7	1.0	3,290
Washington WB SRL	26.0	27.0	0.	8.0	1.12	0.7	1.0	3,760
Veterans SB SRL	22.0	100.0	0.0	3.0	1.23	0.7	1.0	2,270

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Washington EB SRL	387	0.45	1,476	0.26	A	3.7	0.4	5
Washington WB SRL	375	0.45	1,692	0.22	A	2.8	0.3	4
Veterans SB SRL	122	0.45	1,022	0.12	A	1.2	0.0	2
INTERSECTION TOTALS	884		4,190	0.21	A		0.7	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT — 301-04
Selectd-Hour Intersection Performance — 28 JUL 87
FJH

INTERSECTION OF Shirley Street & Washington Avenue
Expected Traffic Volumes; Condition F-6 — +88 FROM DI
New Plant Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 — CYCLE TIME 80 SEC
RESIDENTIAL — CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Washington EB SRL	26.0	76.0	0.0	1.0	1.19	0.7	1.0	4,240
Shirley NB SRL	24.0	10.0	82.0	8.0	1.09	0.7	1.0	1,860
Shirley SB SRL	20.0	61.0	7.0	5.0	1.03	0.7	1.0	2,460

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Washington EB SRL	424	0.45	1,908	0.22	A	2.8	0.3	5
Shirley NB SRL	373	0.45	837	0.45	A	9.8	1.0	4
Shirley SB SRL	114	0.45	1,107	0.10	A	1.0	0.0	1
INTERSECTION TOTALS	911		3,852	0.23	A		1.3	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT — 301-04
Selectd-Hour Intersection Performance — 28 JUL 87
FJH

INTERSECTION OF Veterans Road & Winthrop Shore Drive
Expected Traffic Volumes; Condition F-6 — +88 FROM DI
New Plant Weekday Afternoon Peak Hour

METROPOLITAN POPULATION 2,900,000 — CYCLE TIME 80 SEC
RESIDENTIAL — CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Veterans EB RL	13.0	100.0	0.0	15.0	1.08	0.7	1.0	1,720
Winthrop NB SL	20.0	0.0	13.0	0.0	1.03	0.7	1.0	2,840
Winthrop SB SR	20.0	34.0	0.0	0.0	1.06	0.7	1.0	2,830

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Veterans EB RL	170	0.45	774	0.22	A	2.8	0.1	2
Winthrop NB SL	275	0.45	1,278	0.22	A	2.8	0.2	3
Winthrop SB SR	404	0.45	1,274	0.32	A	5.3	0.6	5
INTERSECTION TOTALS	849		3,326	0.25	A		0.9	

SIGNALLED INTERSECTION ANALYSIS

MWRA DEER ISLAND TRFFC IMPACT
Selectd-Hour Intersection Performance

301-04
28 JUL 87
FJH

INTERSECTION OF Crest, Highland, and Revere
Expected Traffic Volumes; Condition F-6
New Plant Weekday Afternoon Peak Hour

+88 FROM DI

METROPOLITAN POPULATION 2,900,000
RESIDENTIAL

CYCLE TIME 80 SEC
CLRNC TIME 4 SEC

APPROACH	APPRCH WIDTH (FT)	% SLOWNG TURNS	% CNFLCT TURNS	% TRCKS	PEAK HOUR FCTR	LOAD FCTR	GEOM FCTR	CPCTY (VPHG)
Highland WB SRL	13.0	27.0	11.0	0.0	1.13	0.7	1.0	1,600
Crest NB SRL	13.0	1.0	27.0	7.0	1.04	0.7	1.0	1,040
Revere EB SRL	21.0	15.0	62.0	0.0	1.12	0.7	1.0	2,600
Revere SB SRL	21.0	53.0	6.0	3.0	1.11	0.7	1.0	2,830

GREEN TIME AS PRESENTLY APPORTIONED

APPROACH	APPRCH VLM (VPH)	EFF G/C	EFFCTV CPCTY (VPH)	V/C	SRVC LVL	DLY PER VEHICLE (SEC)	TOTAL DELAY (VH-HR)	AVG QUEUE (VEH)
Highland WB SRL	81	0.45	720	0.11	A	1.1	0.0	1
Crest NB SRL	360	0.45	468	0.77	C	25.9	2.6	5
Revere EB SRL	420	0.45	1,170	0.36	A	6.6	0.8	5
Revere SB SRL	843	0.45	1,274	0.66	B	19.7	4.6	10
INTERSECTION TOTALS	1,704		3,632	0.46	A		8.0	

Appendix F

APPENDIX F

OFFSHORE GEOTECHNICAL INVESTIGATIONS AND DESIGN CRITERIA FOR THE INTER-ISLAND TRANSPORT SYSTEM

TECHNICAL MEMORANDUM OF

OFFSHORE GEOTECHNICAL INVESTIGATIONS AND DESIGN CRITERIA FOR THE INTER-ISLAND TRANSPORT SYSTEM

SCOPE

The purpose of this technical memorandum is to inventory previous surveys and investigations in the harbor area, document the Facilities Plan marine subsurface investigations (including borings and geophysical surveys), report the results of laboratory tests that characterize soil and rock properties from samples obtained during this recent investigation, and present the geotechnical design criteria for the alternative systems. The scope of the geotechnical investigation was based on supporting analysis and evaluation of the proposed Nut Island-to-Deer Island inter-island conveyance route and alternative outfall pipeline/tunnel routes located up to 7 mi east and northeast of Deer Island. At the time the investigation was conducted, emphasis was placed on the outfall location 3.5 mi northeast of Deer Island.

The report includes:

- General geology of Boston Harbor
- Descriptions of previous investigations
- Description of the Facilities Plan field explorations
- Summary of laboratory testing
- Discussion of the interaction of the geology and physiography along the proposed alternatives
- Design criteria for alternative transport systems
- Listing of reference documents
- Boring logs and soil/rock test results

GENERAL GEOLOGY OF BOSTON HARBOR

The geology of the Boston Basin is treated extensively by LaForge (1932) and most recently by Billings (1976). The surficial geology comprises mostly Pleistocene sediments of glacial origin varying up to a few hundred feet in thickness. In the Boston Harbor area, these deposits generally consist of a primary till forming a thin veneer over the bedrock surface. This is often overlain by a marine clay ("Boston blue clay" or glacial rock flour) up to several tens of feet thick.

The most prominent glacial features in the harbor are the drumlins, which consist of a till having a generally cohesive clayey/silt matrix containing granular pieces from sand to boulder size. Cobbles, pebbles, and occasional boulders, along with sandy or gravelly layers, are often interbedded with the more homogeneous materials. Some drumlins directly overlie bedrock, while others overlie older glacial sediments. Many drumlins form the core of harbor islands, while still others are submerged and buried or surrounded by later marine clays. Marine coastal forces have eroded, remolded, and redeposited these glacial sediments throughout the harbor area.

The bedrock geology of Boston Harbor consists primarily of slightly metamorphosed argillite, locally known as the Cambridge Formation. The

argillite is most commonly observed to be very thinly bedded or laminated to occasionally nonbedded, very fine grained (generally silt to clay size), well indurated, and hard. Several islands in the harbor are composed almost entirely of argillite bedrock, some of which is exposed as outcrops or rocky ledges and shoals. In addition, a belt of conglomerate projects eastward into the harbor from the mainland and is exposed on Moon Head (Island). Many dikes and sills of trap rock (basalt or diabase) intrude or cut the argillite throughout the harbor area and are also observed on various islands. In general, from Green Island outward to The Graves, numerous islands and ledge exposures, including most of the Brewster Islands, are composed entirely of "trap rock" (Crosby, 1936; Zen, 1983).

Structurally, there are several east-northeast trending folds and faults that characterize the mainland and are projected eastward into the harbor. The folds are observed to plunge east-northeasterly with an attitude generally less than 20 degrees.

PREVIOUS INVESTIGATIONS AND INFORMATION

The most recent geotechnical studies concerning Deer Island and vicinity were conducted in 1983 by Goldberg, Zoino & Associates as part of the Havens and Emerson, Deer Island Treatment Plant Facilities Plan. The scope of this study included six offshore borings in the vicinity of proposed wharf structures on the west side of Deer Island and five borings along proposed outfalls east of Deer Island.

Previously in 1981, Metcalf & Eddy, Inc. conducted geotechnical investigations in the study area as part of the Nut Island Site Options Study. Included in this study were two test borings offshore to the north of Deer Island and a total of 24 mi of marine seismic reflection surveys and 2 mi of marine seismic refraction surveys along and adjacent to the alternative inter-island and outfall conduit routes considered in the Site Options Study. Stone & Webster Engineering Corporation (SWEC), in 1980, conducted marine investigations (borings and geophysical surveys) for the Boston Edison Edgar Station power plant in Weymouth, Massachusetts. In the area of Nut Island and Peddocks Island, the study included three offshore borings, 8 mi of seismic reflection survey, and 1 mi of seismic refraction survey. Figures 1 and 2 illustrate the type and extent of these previous studies.

Further information regarding bedrock and tunneling conditions is provided by various authors in describing numerous MDC tunneling projects in and around the Boston Harbor vicinity. A listing of the references annotated herein and additional applicable noteworthy references are provided at the end of this report.

FACILITIES PLAN FIELD EXPLORATIONS

The current program consisted of five offshore test borings, five seismic refraction survey lines covering a length of 14 mi, and four seismic reflection survey lines totaling 13 mi. Figures 1 and 2 illustrate the locations of the current studies. SWEC engineering personnel were present during the data collection phases of the work.

The borings taken for the Facilities Plan were located in the areas 1) of Broad Sound, 2) east of the Brewster Islands, and 3) between Nut Island and Deer Island. The borings were intended to define the soil profile, depth to bedrock, and type of bedrock. The seismic surveys were structured to obtain new information on soil and bedrock characteristics and depth-to-bedrock information in the area east of the Brewster Islands and to supplement existing data about conditions between Nut Island, Long Island, and Deer Island, and in Broad Sound and Massachusetts Bay.

The test borings were performed from a self-propelled jack-up platform by Warren George, Inc. of Jersey City, New Jersey, between December 22 and December 29, 1986. Three borings (0-1, 0-2, 0-3) were located in the areas of the alternative outfall alignments in Broad Sound and east of the Brewster Islands. The remaining two borings (T-1, T-2) were located along the proposed inter-island alignment between Nut Island and Deer Island. The platform position was determined by an onboard Loran navigational system and verified by land-based survey control methods as observed during drilling at each boring location by Bryant Associates, Boston, MA. The drilling was supervised and all samples were logged by SWEC personnel. At each boring, split spoon samples and standard penetration tests (SPT) were taken at 5-ft depth intervals. Undisturbed Osterberg samples were taken in selected borings. Depth to bedrock was determined at all boring locations and rock core was obtained from four of the five borings. Logs of the borings are attached to this memorandum.

The geophysical surveys were conducted by Weston Geophysical Corporation, Westboro, Mass, from December 2 to December 23, 1986. A total of 9 linear mi of seismic reflection and refraction surveys was conducted in the Broad Sound and Massachusetts Bay areas up to a distance of 5 miles northeast of Deer Island. East of the Brewster Islands, a 1.5-mile seismic reflection survey was completed; between Nut Island and Deer Island, the survey consisted of 2.5 miles of refraction lines. Detailed information from this program is presented in the Weston Geophysical Report dated February 1987.

On April 15, 1987, MWRA and SWEC geologists inspected several islands in the vicinity of the proposed inter-island route between Nut Island and Long Island. Observations from this inspection are discussed in a subsequent section of this report.

LABORATORY TESTING

Selected samples of soil and rock were tested for their respective index, strength, and hardness properties. All testing was performed by the SWEC Geotechnical Laboratory. The results of the laboratory testing are presented in Tables 1 and 2.

Classification of several samples of the silty clay taken from borings 0-1, T-1, and T-2 shows that it is generally very soft to medium stiff and moderately plastic with an average undrained compressive strength (qu) of approximately 1 TSF (pocket penetrometer value). Laboratory testing of undisturbed samples of softer portions of the clay yielded the following consolidation and strength characteristics:

Max. Past Pressure	4.0 KSF
Compression Index	0.43
Recompression Index	0.03
Unconsolidated-Undrained Triaxial Compression	0.6 KSF

The results of testing on selected samples of argillite rock core from borings 0-2, 0-3, and T-2 are summarized as follows:

	Average	Range
Axial Compressive Strength	11,000 psi	4,107-15,800 psi
Tensile Strength (Brazilian)	805 psi	448-1,081 psi
Unit Weight	164.9 pcf	162.9-166.1 pcf
Schmidt Rebound Hardness Index	50.3	36.5-56.2
Point Load Strength Index	798	492-1,053

The results are comparable to the results of similar testing by others, as summarized in the 1983 Metcalf and Eddy Nut Island Site Options Study and the 1980 SWEC report for Boston Edison. The somewhat lower average rock strength test results from the Facilities Plan investigation (11,000 psi versus 15,000-19,000 psi) may be attributed to the effects of weathering at the shallow depths of sample retrieval.

DISCUSSION OF RESULTS

Based on the drilling and geophysical survey information obtained from this program and supplemented by data collected from earlier programs, the bedrock surface is observed to be highly irregular along all of the alternative inter-island and outfall alignments, as illustrated by the bedrock contours shown on Figures 3 and 4, respectively. Figures 5, 6a, 6b, and 7 are soil/bedrock profiles along the Nut Island to Deer Island inter-island alignment, an outfall alignment section extending 6 to 7 mi out into Broad Sound and Massachusetts Bay northeast of Deer Island, and along a section east of the Brewster Islands, respectively. Figures 3 and 4 provide the locations of the profile sections. Deep valleys and holes in the bedrock surface are mainly filled with soft clays, silts, and/or till with combined thicknesses exceeding 100 ft in isolated areas. Immediately overlying the rock surface is a dense basal till of varying thickness. The thickness of soils at the boring locations varied from less than 10 ft at the outermost locations in Broad Sound and east of the Brewster Islands to 40 to 80 ft at locations closer to Deer Island and between Deer Island and Nut Island. The geophysical surveys and borings indicated that the thicker soil deposits change with increasing depth, from very soft or medium stiff silty clays to very hard or very dense tills.

The bedrock observed in the borings from this investigation is characterized as gray argillite and is generally very thinly bedded to occasionally nonbedded. Bedding is manifested by alternating light gray and dark gray banding. Conditions of the rock were variable with some observable weathering in the uppermost several feet. Generally, the rock was sound and competent with the quality improving with depth.

The argillite comprises mostly silt-size particles consisting predominantly of quartz, sericite, and chlorite (Billings, 1975) with the dark gray to black layers representing organic and/or clay-sized materials (Hatheway & Paris, 1979). The rock is highly indurated and generally moderately hard to hard relative to the degree of banding and the quartz content. Foliation (parting) planes are quite common in the laminar argillite, occur with variable frequency, and coincide with the prevailing bedding attitude.

Observed joints or fractures are often healed with calcite and/or contain a trace to a film of calcite or occasionally clay. Joints vary from smooth to irregular. No slickensides were observed on any of the planar rock surfaces; however, several healed shears with minor offsets in bedding laminations (<1.0 in.) were noted. Similarly, local areas of irregular or disturbed bedding are indicative of contemporaneous deformation or slumping. Between Nut Island and Deer Island, several major faults and folds are expected. Also, the regional strike in the harbor area is expected to range between N45°E and N80°E (Kaye, 1984; Wheby, 1978).

Bedrock exposures of gray argillite were noted at Quarantine Rocks and at the southwest end of Rainsford Island. The argillite at both locations was complexly folded with observed metamorphic overprinting, closely spaced jointing, and evidence of shearing. Similar observations were made at Hangman Island, which was additionally complicated by the presence of diabase or basalt (trap rock) and quartzite.

Previous investigations and earlier tunneling projects in Boston and the harbor area have revealed the presence of a variety of rock types, numerous fault zones, folds, intrusive dikes and sills, and kaolinized zones within the argillite rock. Among the other rock types that have been encountered are conglomerate, tillite (diamictite), slate, shale, sandstone, quartzite, tuff, diabase, rhyolite, and andesite. (Rahm, 1962; Billing, 1975; Kaye, 1967). Of particular interest is the conglomerate encountered at a shallow boring near Peddocks Island (SWEC, 1980) and tillite observed at Moon Head (Kaye, 1984, and Crosby, 1936). These occurrences straddle the inter-island alignment area south of Long Island.

Due to the pervasiveness of the Cambridge Formation and the attitude of the bedding observed in the rock core and harbor island exposures, it may be assumed that bedrock in both the outfall and inter-island study areas will be predominantly argillite with kaolinized zones expected. Bedrock along the inter-island alignment is expected to include occasional intrusions of fine- grained igneous rock and the possibility of occurrences of conglomerate or tillite. Along the outfall alignments, the proportion of diabase or basalt is anticipated to increase toward the outer islands.

PIPELINE DESIGN CRITERIA

A pipeline with an inside diameter of 11 ft would be installed, extending from Nut Island to Long Island in up to 35 ft of water along the alignment shown on Figure 8. The pipeline routing is dictated by minimizing the extent of bedrock to be excavated, since underwater bedrock excavation is an extremely costly and time-consuming activity. As such, bedrock is estimated to occur over a 500-ft-long segment located 3500 ft southeast of Long Island.

The pipeline trench would be excavated in the harbor soils by clamshell or dragline and the materials transferred to a barge for transport to an ocean disposal site. Hydraulic dredging is not considered an option because of the coarse nature of a portion of the soils and the siltation potential associated with the fine-grained fraction of the soil matrix. The trench would be excavated from 20 ft to 40 ft below the harbor bottom. The depth is a function of the bottom elevation profile and the pipe invert elevation required to maintain a minimum downward slope from Nut Island toward Long Island.

The trench must be at least 20 ft wide and be overexcavated 2 ft vertically. The verticality of the trench cut slopes would vary from nearly vertical in bedrock and stiff glacial tills to a flatter slope such as 4H:IV in soft silt or clay. The average cut slope for the trench excavated in soil is estimated at 2H:IV. Accounting for overbreak and bedrock irregularities due to weathering or joint patterns, a 1H:4V backslope is estimated for the trench along the bedrock excavation section.

The pipeline would require uniform vertical and lateral support. To this end, all trench sections would be overexcavated a minimum of 10 ft laterally and 2 ft vertically. Prior to pipe installation, a 2-ft layer of bedding stone will be placed. Once the pipeline is in place, the trench would be backfilled to the top of the pipe with select granular backfill or crushed stone. This backfill would extend out a minimum distance of 20 ft on both sides of the pipe springline. Beyond that dimension, any remaining trench cut would be left open to be filled over time by harbor bottom soils transported by tidal or storm forces.

Pipeline protection against anchor dragging or erosive storm wave forces would be provided by a 6-ft-thick layer of armor stone having a minimum stone size of 18 in. Within the surf zone of Nut Island and Long Island, this layer thickness would be increased to 10 ft. Laterally, the armor stone layers would extend a minimum of 20 ft beyond the pipe perimeter. The pipe invert elevation would be controlled such that the top of the armor stone layer would not extend above the current harbor bottom grade. In the event that the top of the armor layer terminated below grade or did not completely fill the trench cross section, the unfilled areas would be left to fill in over time under the action of wave or tidal force movement of harbor bottom soils.

TUNNEL DESIGN CRITERIA

The inter-island tunnel alternatives (11-ft I.D.) are from Nut Island to Deer Island and from Long Island to Deer Island.

There are two alternative tunnel alignments along the inter-island route: 1) Nut Island to Deer Island, and 2) Long Island to Deer Island combined with a pipeline (or sunken tube) between Long Island and Nut Island, as shown on Figure 8. The geotechnical design criteria would be the same for both tunnel options, since the two alignments are separated by less than one-half mile. The geologic profile assumed to be identical for the two alternate tunnel alignments is shown on Figure 5.

The tunnel crown would be located a minimum of three tunnel diameters below the lowest point in the bedrock surface in order to minimize the effect of stress concentrations in the overlying bedrock due to the presence of the tunnel. Since the tunnel will be maintained at a constant downward slope toward Deer Island for flow considerations, there are locations along the alignment where the bedrock cover over the tunnel increases to nearly 200 ft.

The predominant rock type anticipated along the alignment is Cambridge argillite. This rock is medium hard with unconfined compressive strength test values that vary from 4 ksi to 45 ksi, with an average value of 20 ksi. Hardness or average compressive strength values have not been established for other less dominant rock types likely to be encountered along the alignment, including diabase intrusions, tillite, or conglomerate. It is anticipated that the tunnel would be mined by a tunnel boring machine (TBM), unless additional field studies during the design phase of the project determine that the nature of the bedrock along sizable extents of the alignment are not economical for TBM mining. For example, extensive conglomeritic rock or kaolinized zones would likely have an adverse effect on the progress and economics of a TBM. Based on the information established to date on rock strength, hardness, and bedding characteristics, it is predicted that the tunnel excavation would proceed at a rate of 70 ft/day, a value considered moderate by today's standards.

Previous tunnel experience in Boston Harbor has demonstrated that rock supports would probably be required for portions of the tunnel length. Weaknesses in the argillite can result from faults, diabase intrusions, bedding configurations, or kaolinized zones. Rock supports along the previously constructed Boston Basin tunnels have been required over tunnel lengths varying from less than 1 percent to an extreme case of 50 percent of the length with an average of 20 percent of the length. For the present, rock bolting and grouting have been estimated for 15 percent of the length, since improvements in tunneling technology over the past 20 years have resulted in a reduction in the overall need for rock support.

Based on the previous harbor tunnel experiences, major inflows of water into the tunnel through the bedrock would not be anticipated during construction, unless severely faulted or other major altered rock zones were encountered. Any water seepage entering the tunnel would be expected to be brackish. Control of water inflow during construction would be by channeling it back down the tunnel invert to sump locations.

The tunnel would be lined with either precast concrete sections or cast-in-place concrete. Final liner design, including thickness and reinforcing, would be based on an evaluation of the internal and external pressures and the load transfer characteristics to the bedrock. For conceptual and engineering order-of-magnitude cost estimating purposes, a 12-in.-thick, cast-in-place, reinforced concrete liner has been designated. The design would allow access for overbreak grouting; however, due to the nature of the argillite and TBM-mining techniques the actual overbreak should be minimal.

It is anticipated that the tunnel spoils, for the most part, would be in the particle size range of coarse gravel to medium sand with some fine sand and

silt-size particles. Specific uses for the spoils on Deer Island such as structural fill, berm fill, or an alternate use (such as for concrete aggregate) will be determined during the design phase of the project.

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TABLE 1 (PAGE 1 OF 2)

SUMMARY OF SOIL TESTS

LABORATORY SOIL DESCRIPTIONS AND INDEX TESTS

BORING NO.	SAMPLE	DEPTH (FT)	APPROX. MDC ELEV. (FT)	NATURAL WATER CONTENT(%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	LIQUIDITY INDEX (%)	POC.PEN. Qu(1) (TSF)	SOIL DESCRIPTION(2)
01	SS2	5.0-7.0	67-65	32.4	44.1	19.6	24.5	52	1.25	SILTY CLAY
	SS3	10.0-12.0	62-60	----	----	----	----	--	0.75	SILTY CLAY
	SS5	20.0-22.0	52-50	44.4	51.8	22.6	29.2	75	0.50	SILTY CLAY
	SS7	30.0-32.0	42-40	45.7	54.1	23.1	31.0	73	----	*SILTY CLAY
	U011	50.0-52.0	22-20	46.1	50.5	21.9	28.6	85	0.75	*SILTY CLAY
	SS13	60.0-62.0	12-10	----	----	----	----	--	----	SILTY CLAY
	SS14	65.0-67.0	7-5	----	----	----	----	--	----	SILTY CLAY
	SS15	70.0-72.0	2-0	25.6	25.7	14.7	11.0	99	----	SILTY CLAY
02	SS1	0.0-2.0	60-58	----	----	----	----	--	----	SILTY GRAVEL, SOME SAND
T1	U02	6.0-8.0	62-60	45.3	53.5	23.6	29.9	73	0.75	SILTY CLAY
	SS7	30.0-32.0	38-36	40.9	48.2	21.7	26.5	73	0.25	SILTY CLAY
	SS11	50.0-52.0	18-16	----	----	----	----	--	----	CLAYEY GRAVEL, SOME SAND
T2	SS3	11.0-13.0	69-67	36.7	49.3	21.9	27.4	54	1.75	SILTY CLAY
	SS7	30.0-32.0	50-48	----	----	----	----	--	----	*GRAVELLY SILTY SAND

NOTE (1) UNDRAINED COMPRESSIVE STRENGTH DETERMINED BY POCKET PENETROMETER
NOTE (2) VISUAL DESCRIPTIONS UNLESS NOTED BY * INDICATING GRAIN SIZE ANALYSIS PERFORMED

TABLE 1 (PAGE 2 OF 2)

SUMMARY OF SOIL TESTS

INCREMENTAL CONSOLIDATION TEST(1)

BORING NO	SAMPLE	DEPTH (FT)	APPROX. MDC ELEV. (FT)	SPECIMEN DIAMETER (IN)	SPECIMEN HEIGHT (IN)	INITIAL WATER CONT.(%)	DRY UNIT WEIGHT (PCF)	INITIAL VOID RATIO	MAX. PAST PRES (TSF)	COMPRESSION RATIO LAB(2)	COMPRESSION RATIO FIELD(3)
01	U011B	51.2	21	2.5	0.75	41.8	81.1	1.06	2.0	0.198	0.210

RECOMPRESSION RATIO
0.027

NOTE (1) TEST PERFORMED ON SILTY CLAY
NOTE (2) RATIO FROM LABORATORY CURVE
NOTE (3) RATIO FROM SCHMERTMANN GRAPHICAL CONSTRUCTION TECHNIQUE

UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST(1)

BORING NO.	SAMPLE	DEPTH (FT)	APPROX. MDC ELEV. (FT)	SPECIMEN DIAMETER (IN)	SPECIMEN HEIGHT (IN)	WATER CONTENT (%)	RATE OF STRAIN (%/MIN)	CONFINING PRESSURE (KSF)	AXIAL STRESS (KSF)	AXIAL STRAIN (%)
T1	U02D	6.7	61	2.67	6.58	43.7	0.23	1.44	1.32	15

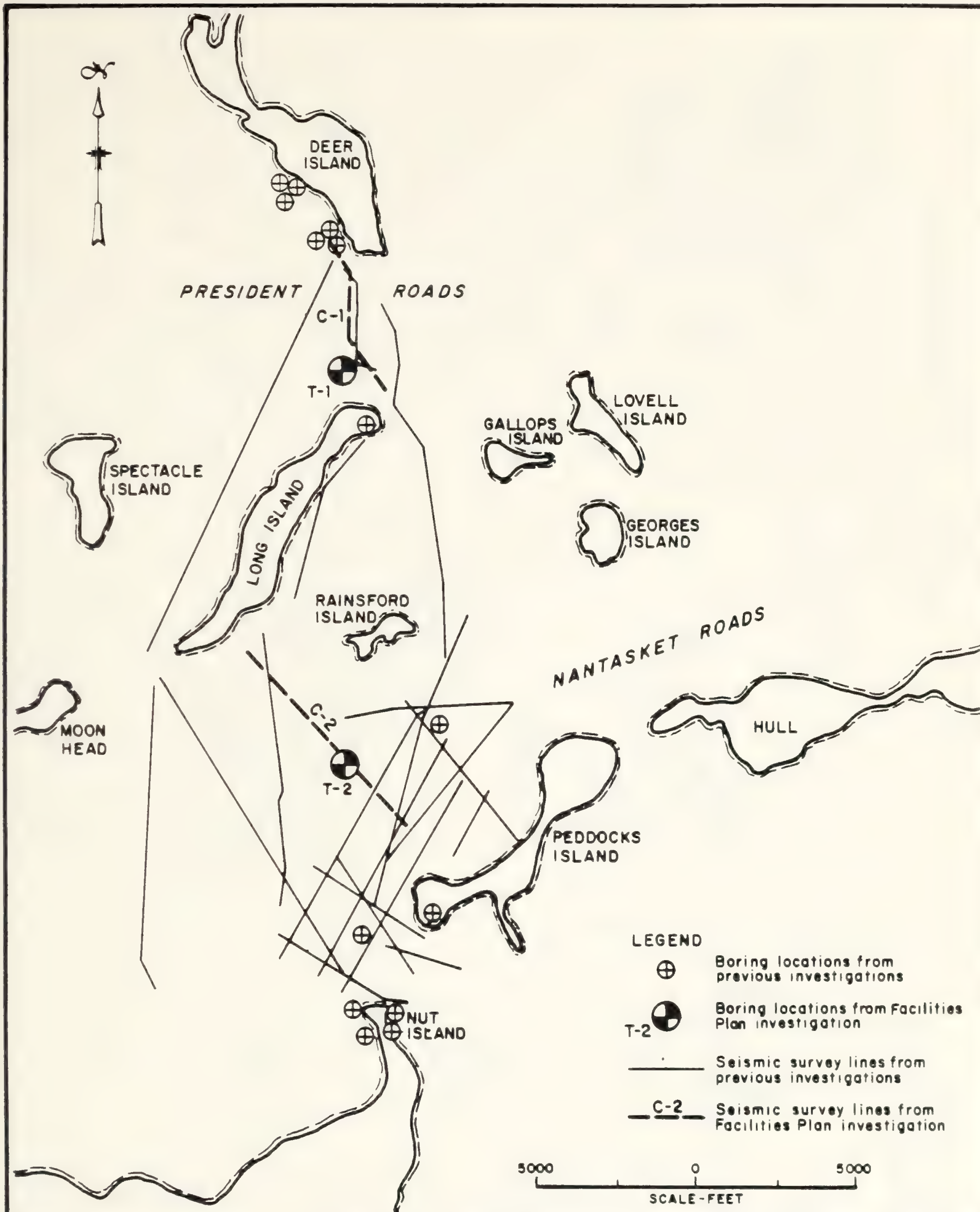
NOTE (1) TEST PERFORMED ON SILTY CLAY

TABLE 2

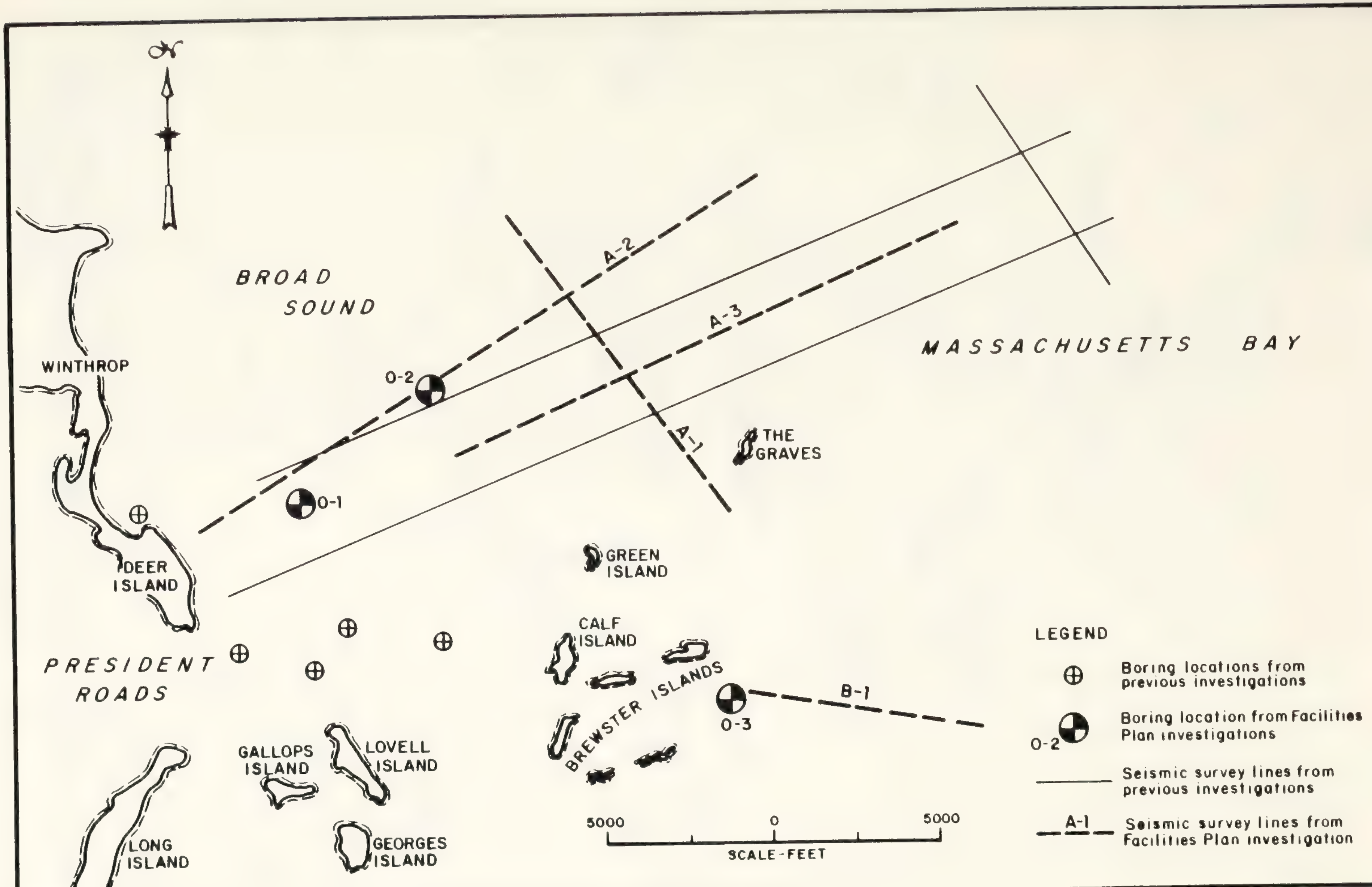
SUMMARY OF ROCK TESTS(1)

BORING NO.	DEPTH (FT)	APPROX. MDC ELEV. (FT)	UNIT WEIGHT (PCF)	BRAZILIAN TENSILE TEST SPECIMEN DIAMETER (IN)	SPECIMEN LENGTH (IN)	SPLITTING STRENGTH (PSI)	REBOUND HARDNESS INDEX(2)	PLS INDEX(3) (PSI)	AXIAL COMP. STRENGTH (PSI)
02	19.4-20.0	40	165.6	1.98	1.01	968.7	56.2	758	14341
	30.6-31.6	29	-----	1.99	1.07	940.3	55.9	959	-----
03	9.9-10.9	50	165.1	1.94	0.99	1080.7	55.1	995	9896
	18.4-19.2	41	166.1	1.98	1.00	846.9	55.6	1053	15800
T2	44.2-45.7	35	162.9	1.98	1.24	546.1	36.5	492	4107
	56.2-58.7	22	-----	1.95	0.96	447.9	42.5	532	----

NOTE (1) TESTS PERFORMED ON GRAY, FRESH ARGILLITE
NOTE (2) SCHMIDT REBOUND HARDNESS INDEX FOR TYPE L HAMMER
NOTE (3) POINT-LOAD STRENGTH INDEX TESTS PERFORMED ON SPECIMENS AFTER REBOUND HARDNESS MEASUREMENTS. SPECIMEN DIAMETER 50 MM.

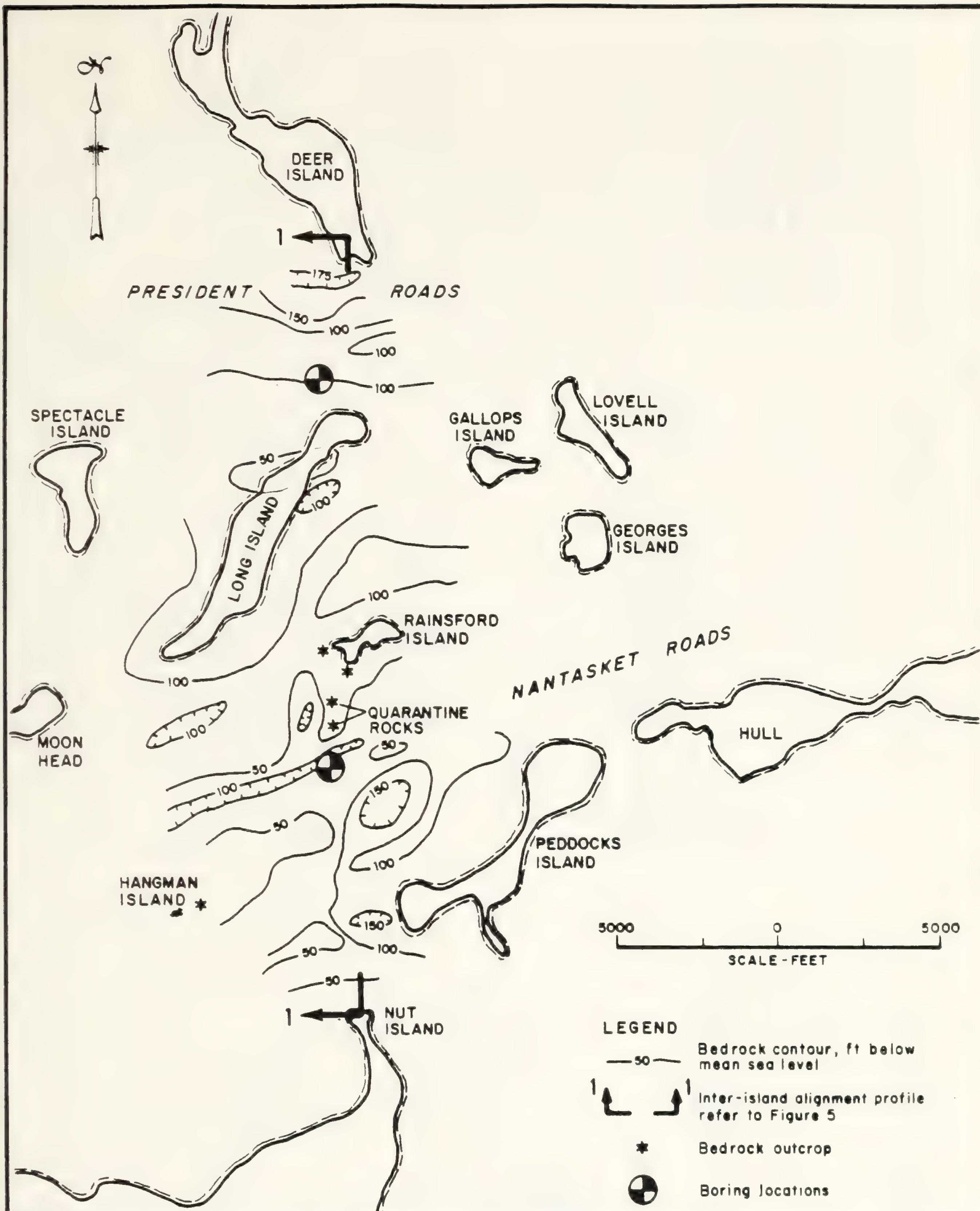


MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 1 INTER-ISLAND GEOTECHNICAL INVESTIGATIONS



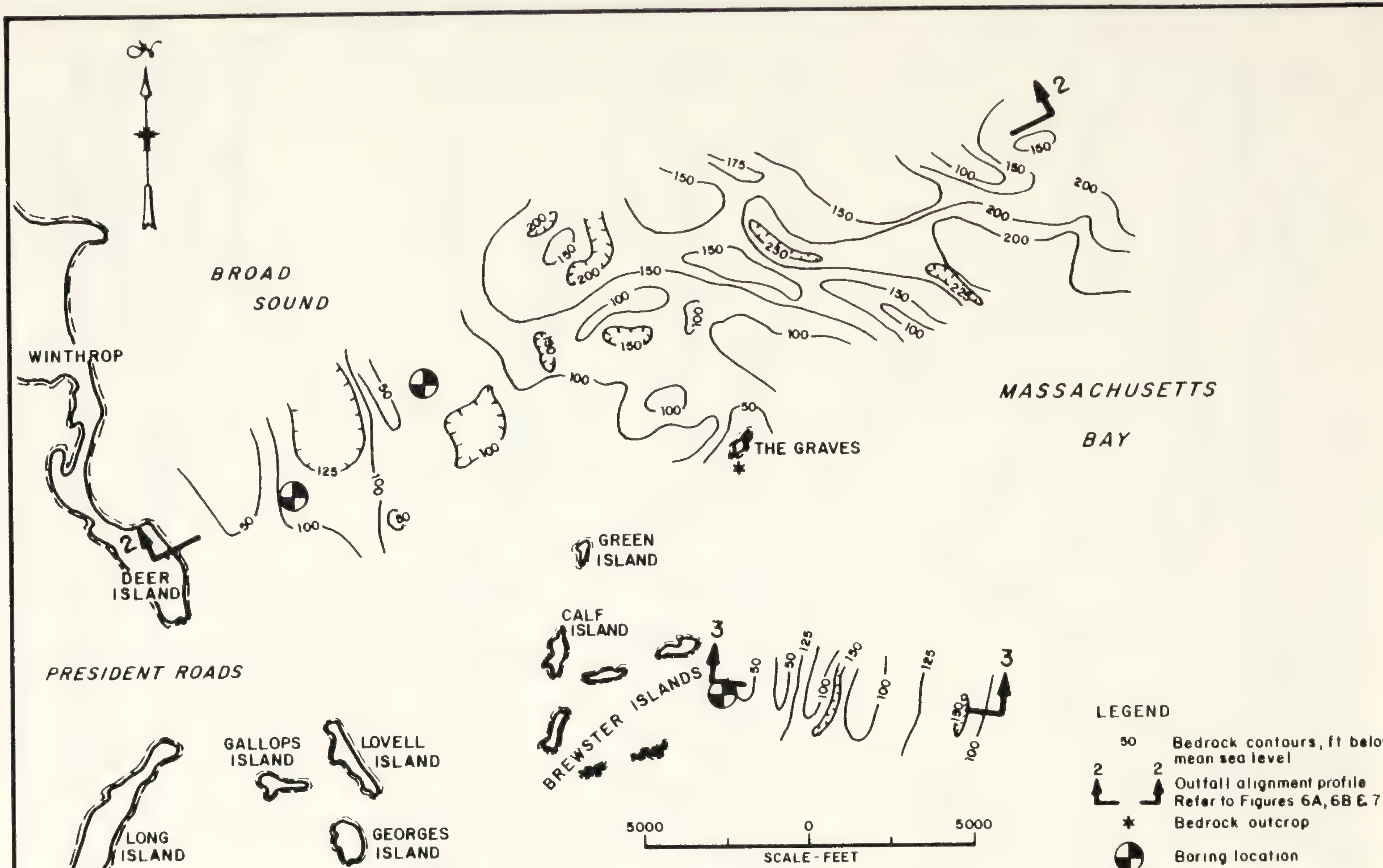
MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 2
OUTFALL GEOTECHNICAL INVESTIGATIONS



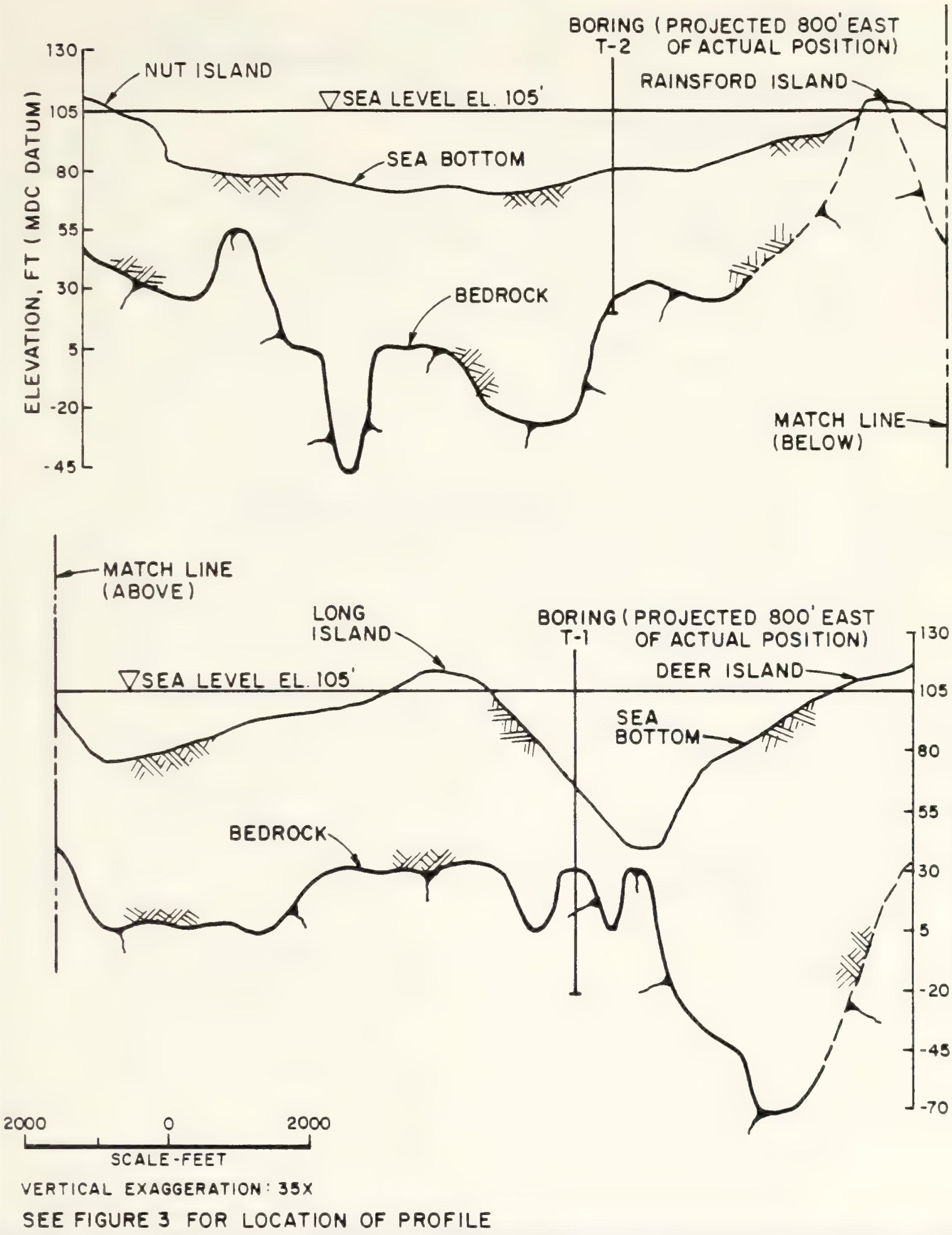
MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 3
INTER-ISLAND BEDROCK CONTOURS



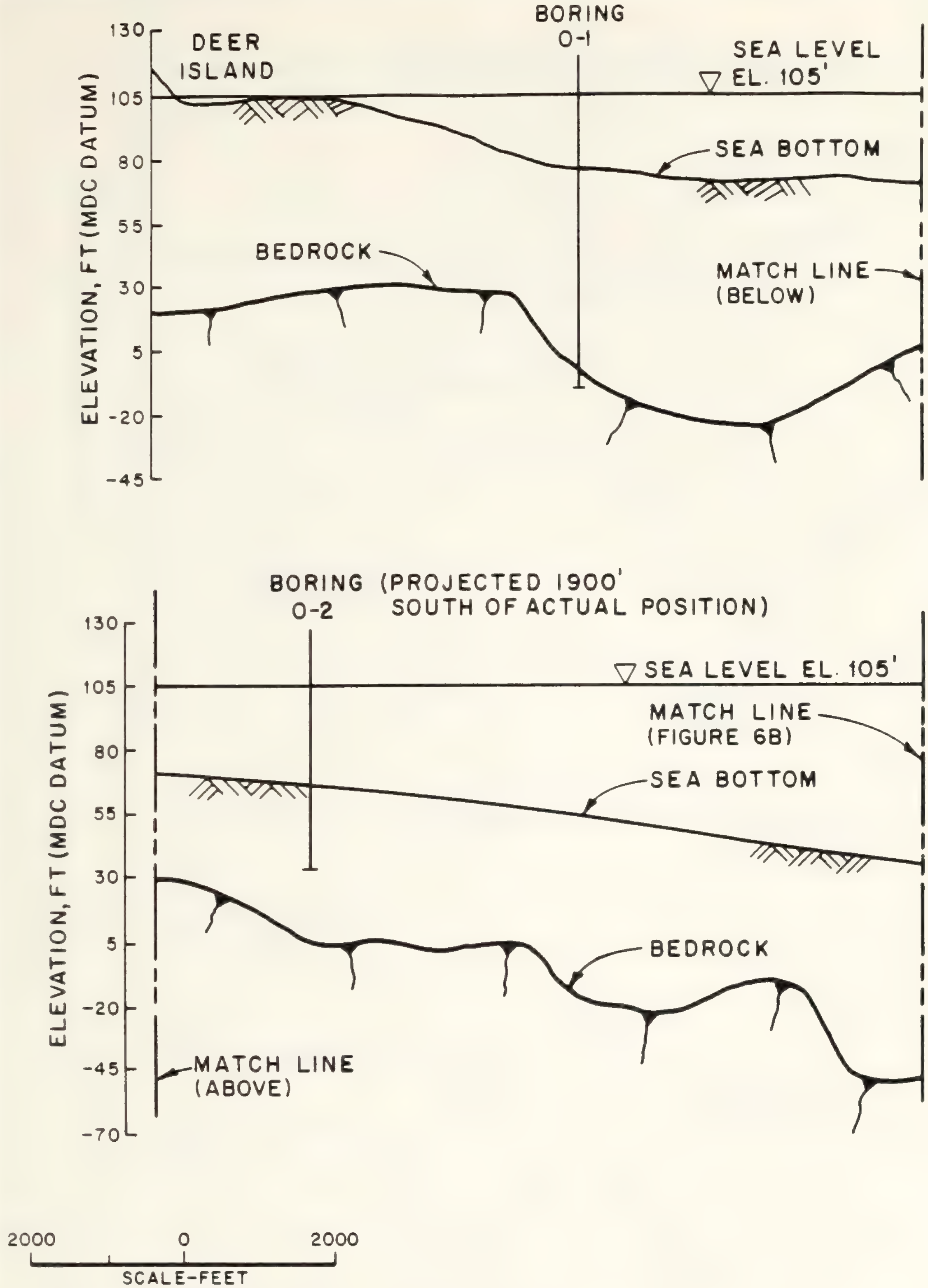
MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 4
OUTFALL AREAS BEDROCK CONTOURS



MASSACHUSETTS WATER RESOURCES AUTHORITY

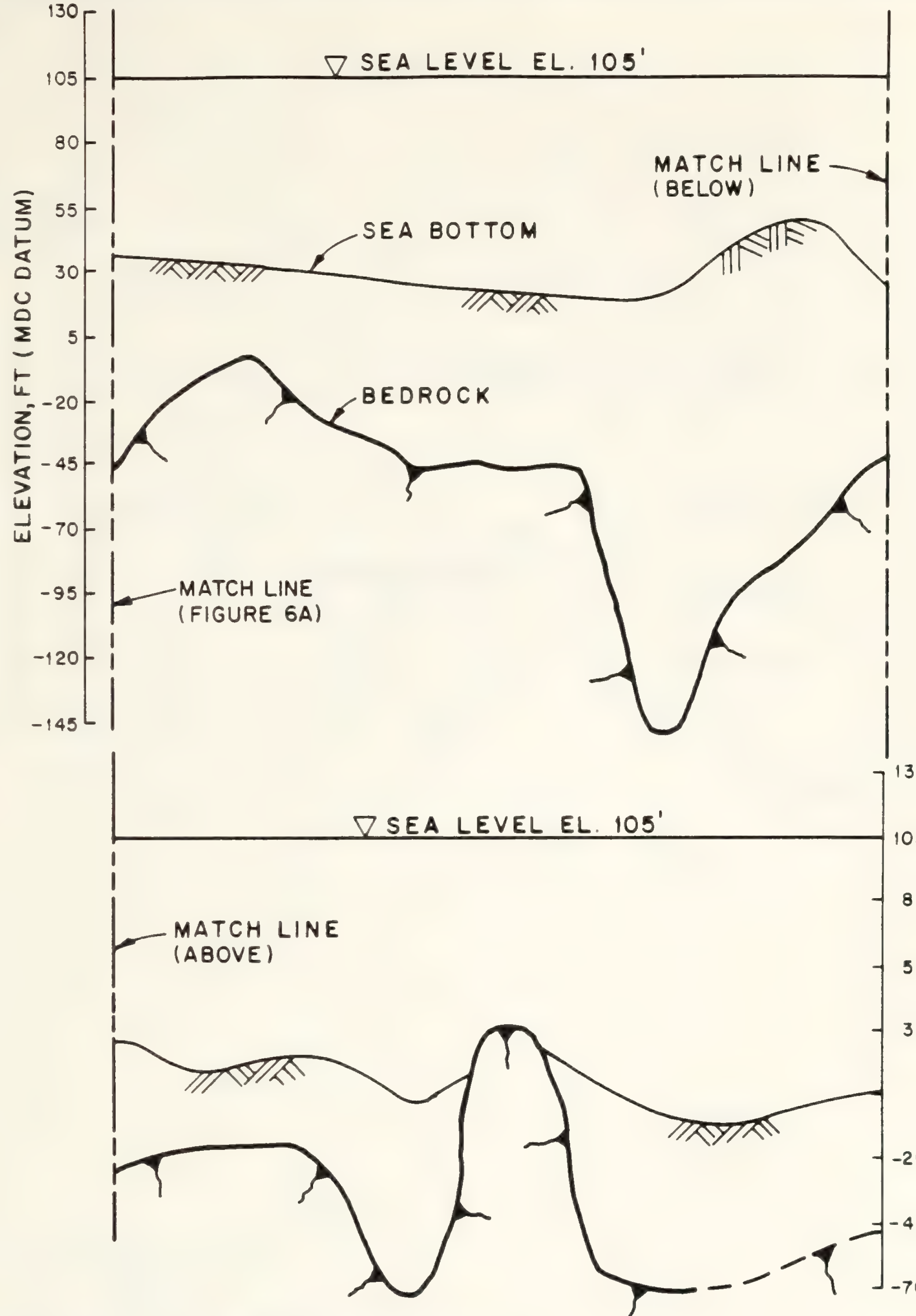
FIGURE 5 (SECTION 1-1)
INTER-ISLAND ALIGNMENT PROFILE



VERTICAL EXAGGERATION: 35X

SEE FIGURE 4 FOR LOCATION OF PROFILE

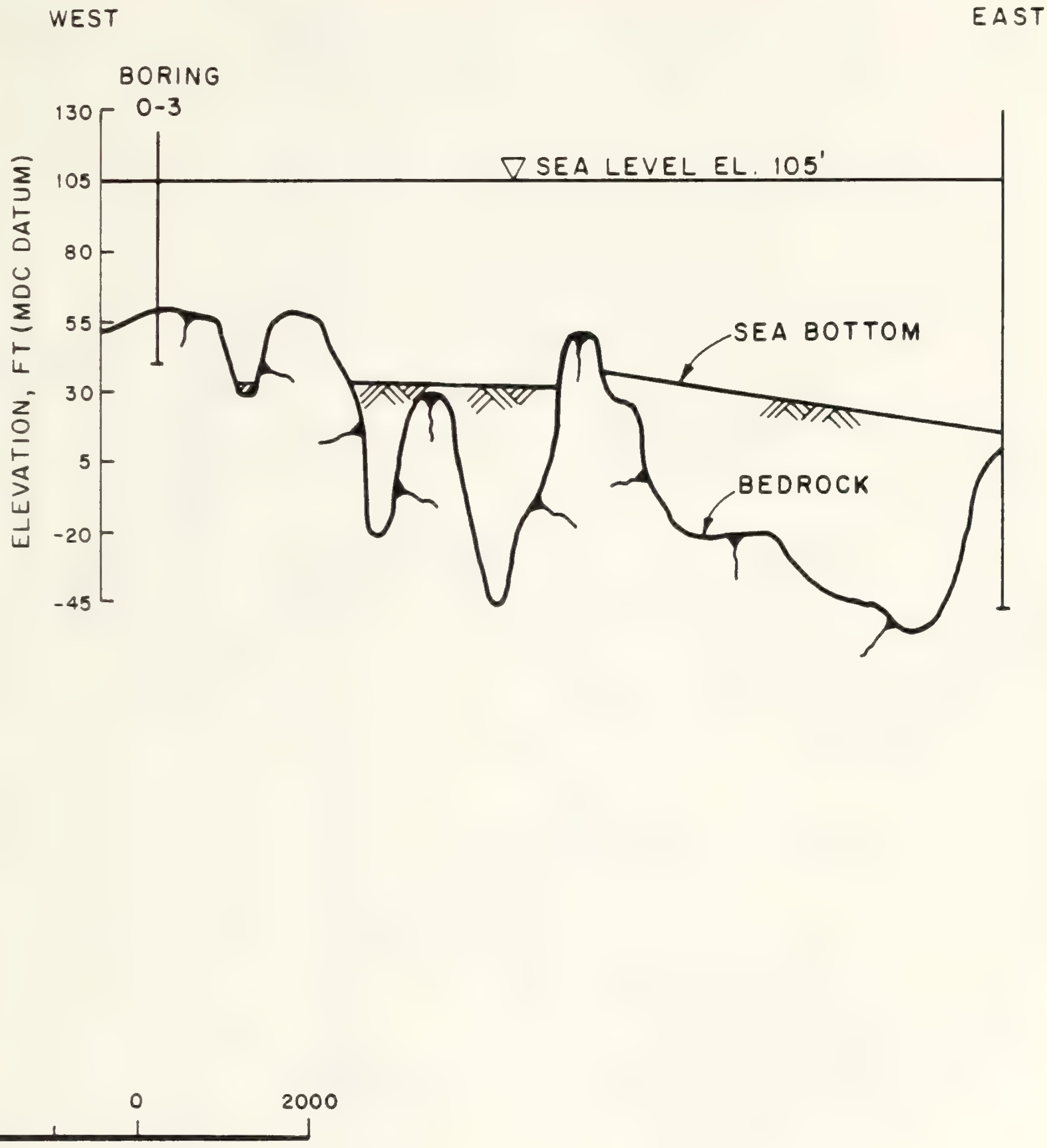
MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 6A (SECTION 2-2) OUTFALL ALIGNMENT PROFILE (BROAD SOUND AREA)



SEE FIGURE 4 FOR LOCATION OF PROFILE
SEE FIGURE 6A FOR SCALE AND NOTES

MASSACHUSETTS WATER RESOURCES AUTHORITY

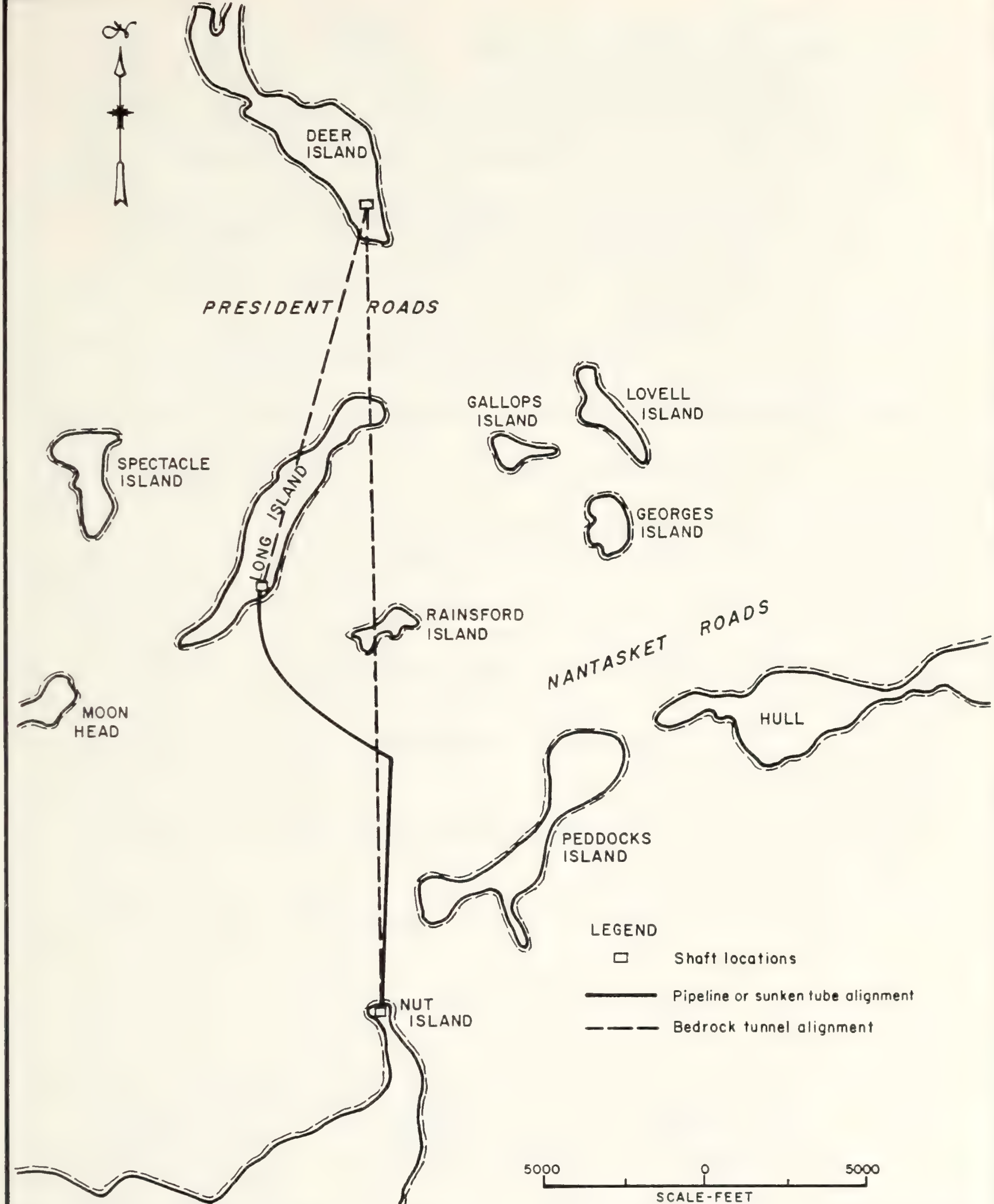
FIGURE 6B (SECTION 2-2)
OUTFALL ALIGNMENT PROFILE
(BROAD SOUND AREA)



VERTICAL EXAGGERATION: 35 X

SEE FIGURE 4 FOR LOCATION OF PROFILE

MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 7 (SECTION 3-3) OUTFALL ALIGNMENT PROFILE (BREWSTER ISLAND AREA)



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 8
INTER-ISLAND CONDUIT ALTERNATIVES

SITE DEER ISLAND SECONDARY TREATMENT FACILITY J.O. NO. 16100.08

BORING NO. 01 SHEET 1 OF 2

COORDINATES 42°21.55'N 70°56.21'W GROUND ELEV. (1) APPROX. +72 FT

INCLINATION VERTICAL BEARING --- INSPECTOR KILKER/BROWN/OLSZEWSKI

DATE : START / FINISH 12-26-86 / 12-27-86 CONTRACTOR / DRILLER WARREN GEORGE/MARNEY

STATIC GROUNDWATER DEPTH / DATE - (FT) / - DRILL RIG TYPE DIEDRICH D-50

DEPTH TO BEDROCK 80 (FROM SEA BOTTOM) (FT) TOTAL DEPTH DRILLED 86 (FT)

METHODS :

DRILLING SOIL ROLLER BIT TO 80 FT

SAMPLING SOIL SPLIT SPOON AT 5 FT INTERVALS TO 80 FT. OSTERBERG SAMPLE AT 50 FT

DRILLING ROCK NX CORE 80.0 - 86.0 FT

SPECIAL TESTING OR INSTRUMENTATION

COMMENTS WATER DEPTHS: 30 FT-37 FT (TIDAL VARIATION).

LOST CIRCULATING WATER AT TOP OF ROCK. CASING INSTALLED TO 80 FT.

ELEVATION (FEET)(1)(2)	DEPTH (FEET)	SAMPLE TYPE (7)	SAMPLE NUMBER	BLOWS (3) OR REC/RQD (4)	SPT N VALUE (5)	GROUP SYMBOL (6)	SAMPLE DESCRIPTION
	0	SS	1	WOR-4-5	4		NO RECOVERY.
70							
	5	SS	2	9-7-5-6	12	SM, CL	SILTY SAND, VERY FINE, 12-15% NONPLASTIC FINES, MEDIUM DENSE, WET, GRAY. SILTY CLAY, MODERATELY PLASTIC, STIFF, GRAY.
	10	SS	3	3-4-4-5	8	CL	SILTY CLAY, MODERATELY PLASTIC, FIRM, GRAY.
60							
	15	SS	4	2-2-2-3	4	CL	SILTY CLAY, MODERATELY PLASTIC, SOFT, GRAY, 1" LENS OF SILTY SAND AT 16 FT.
	20	SS	5	WOH-4-5	4	CL-CH	SILTY CLAY, MODERATELY TO HIGHLY PLASTIC, SOFT, GRAY.
50							
	25	SS	6	WOH-5	-	CL-CH	SILTY CLAY, SIMILAR TO ABOVE EXCEPT VERY SOFT.
	30						

LEGEND / NOTES

1. DATUM IS MDC SEWER DATUM (MDC=USGS+105.62 FT).
2. ▽ GROUND WATER LEVEL
3. BLOWS REQUIRED TO DRIVE 2" O.D. SAMPLE SPOON 6" OR DISTANCE SHOWN USING 140lb. HAMMER FALLING 30". * INDICATES USE OF 300lb. HAMMER. ( ) INCHES OF SAMPLE RECOVERY.
4. % ROCK CORE RECOVERY/ ROCK QUALITY DESIGNATION.
5. STD. PENETRATION RESISTANCE BLOWS/FT.
6. UNIFIED SOIL CLASSIFICATION SYSTEM.
7. SS = SPLIT SPOON.
   UO = UNDISTURBED OSTERBERG.
   NX = 2 IN. DIAMETER ROCK CORE.

BORING LOG

DEER ISLAND SECONDARY TREATMENT FACILITY

MWRA

STONE & WEBSTER ENG. CORP.
SKETCH No.

APPROVED	DATE	BORING NO.	SHEET
WEKilker	2-12-87	01	1 OF 2

BORING NO. 01

SHEET 2 OF 2

SITE DEER ISLAND SECONDARY TREATMENT FACILITY J.O. NO. 16100.08

ELEVATION (FEET)(1&2)	DEPTH (FEET)	SAMPLE TYPE (7)	SAMPLE NUMBER	BLOWS (3) OR REC/RQD (4)	SPT N VALUE (5)	GROUP SYMBOL (6)	SAMPLE DESCRIPTION
40	30	SS	7	WOR	—	CH	SILTY CLAY, HIGHLY PLASTIC, VERY SOFT, GRAY.
	35	SS	8	WOR-WOH	—	CH	SILTY CLAY, SIMILAR TO ABOVE, EXCEPT BOTTOM 1" CONTAINED SOME FINE GRAVEL.
30	40	SS	9	WOR	—	CH	SILTY CLAY, HIGHLY PLASTIC, VERY SOFT, GRAY.
	45	SS	10	WOR-WOH	—	CH	SILTY CLAY, SIMILAR TO ABOVE.
20	50	UO	11	WOR	—	CL-CH	SILTY CLAY, MODERATELY PLASTIC, VERY SOFT, GRAY.
	55	SS	12	WOR-WOH	—	CL-CH	SILTY CLAY, SIMILAR TO ABOVE.
10	60	SS	13	WOR-WOH	—	CL-CH	SILTY CLAY, SIMILAR TO ABOVE.
	65	SS	14	WOR	—	CL	SILTY CLAY, SLIGHTLY PLASTIC, VERY SOFT (BOTTOM 8" SOFT), GRAY.
0	70	SS	15	WOR	—	CL	SILTY CLAY, SIMILAR TO ABOVE, EXCEPT TRACT OF MEDIUM SAND-SIZE ARGILLITE FRAGMENTS.
	75	SS	16	32-92-53-35	145	GC	CLAYEY GRAVEL, ANGULAR TO SUBANGULAR, MED. GRAY ARGILLITE FRAGS. TO 1-1/2", 15-20% MODERATELY TO HIGHLY PLASTIC BROWN-GRAY CLAY, 10-15% FINE TO COARSE SAND-SIZE ARGILLITE FRAGS. (MAY BE WX ROCK).
							TOP OF ROCK AT 80 FT.
-10	80	NX	1	100/0			MED. TO DK. GRAY ARGILLITE, V. THIN. LAM. @ 30°, FRESH, MOD. HARD TO HARD, PARTINGS @1/2" TO 3", SMOOTH TO SL ROUGH W/TR. TO SL. CALCITE COATING.
		NX	2	92/92			80.0-81.5 CORE SEVERELY BROKEN DUE TO DISKING ALONG PARTING PLANES (CORE BARREL JAMMED @81.0).
	85						82.0, 83.5, 85.1, 85.2 CALCITE HEALED SHEAR @ 50° (OFFSET ≈ 3mm).
							END OF BORING AT 86.0 FT.

NOTE: FOR BORING SUMMARY AND LEGEND INFO. SEE SHEET 1.

STONE & WEBSTER ENG. CORP. SKETCH No.	APPROVED	DATE	BORING NO.	SHEET
	W Kilkee	2-12-87	01	2 OF 2

SITE [illegible] J.O. NO. [illegible]

COORDINATES 42°22.32'N 70°55.11'W GROUND ELEV. (1) APPROX. +60

SHEET 1 OF 1

INCLINATION VERTICAL BEARING ____ INSPECTOR G. PAGE

DATE : START / FINISH 12-22-86 / 12-23-86 CONTRACTOR / DRILLER WARREN GEORGE/MARNEY

STATIC GROUNDWATER DEPTH / DATE ____ (FT) / ____ DRILL RIG TYPE DIEDRICH D-50

DEPTH TO BEDROCK 6.5 (FROM SEA BOTTOM) (FT) TOTAL DEPTH DRILLED 33 (FT)

METHODS :

DRILLING SOIL ROLLER BIT TO 8 FT

SAMPLING SOIL SPT AT 5 FT INTERVALS TO 7 FT

DRILLING ROCK NX CORE 8 FT TO 33 FT. LOST CIRCULATING FLUID AT 10 FT.

SPECIAL TESTING OR INSTRUMENTATION ____

COMMENTS CASING (4 IN. O.D.) POUNDED TO 8 FT. SAMPLING RODS 2.375 IN. O.D.
WATER DEPTHS: 42 FT TO 46 FT (TIDAL VARIATION)

ELEVATION (FEET)(1&2)	DEPTH (FEET)	SAMPLE TYPE (7)	SAMPLE NUMBER	BLOWS (3) OR REC/RQD (4)	SPT N VALUE (5)	GROUP SYMBOL (6)	SAMPLE DESCRIPTION
60		SS	1	7-7-10-24	17	GM	SILTY GRAVEL, GAP GRADED, ANGULAR TO SUBANGULAR FRAGMENTS UP TO 1 IN., 20-30% SUBANGULAR SAND, 12-20% SLIGHTLY PLASTIC FINES, MEDIUM DENSE, WET, BROWNISH GRAY.
	5	SS	2	63-57-53 130/4½"	110	GM	SILTY GRAVEL, SIMILAR TO ABOVE EXCEPT VERY DENSE, ROCK FRAGMENTS (ARGILLITE) TO 1 IN. WITH PARTINGS AT 1/8 IN. DUE TO SAMPLING. TOP OF ROCK AT 6.5 FT
50	10	NX	1	94/36			(ROLLER BIT TO 8 FT) DK. BROWNISH-GRAY ARGILLITE, V. THIN, LAM. @30°, FRESH TO SL. WX., MOD. HARD TO HARD, NUMEROUS PARTINGS 1/2" TO 2" SPACING, SMOOTH TO IRREG. W/FeO STAIN AND MINOR CALCITE COATING, OCCAS. CALCITE HEALED SHEARS W/OFFSET <1 IN. 8.1-8.7 JT., VERT., ROUGH, FeO STAIN, SL. CALCITE. 10.9-14.7 BEDDING FAINT HORIZ. TO MASSIVE, HARD, NO PARTINGS. 11.0 JT., 20°, ROUGH, SL. CALCITE.
	15	NX	2	100/41			14.3 JT., 35°, OPEN, ROUGH, FeO STAIN, SL. CALCITE. 14.7-21.3 BEDDING @25°-30°. 15.4-16.4 JT. VERT., OPEN, ROUGH, IRREG., FeO STAIN, CALCITE UP TO 1/16" THICK. 16.4-17.0 CORE BROKEN TO GRAVEL FRAGS., FeO STAIN, SL. CLAY COATING. (CORE BARREL JAMMED AT 17 FT)
40	20	NX	3	87/68			17.0-33.0 OCCAS. PARTINGS 1/2" TO 10" SPACING. 17.4-18.0 CALCITE STRINGER/HEALED JT. < VERT., UP TO 1/4" THICK. 20.6 CALCITE FILLED PARTINGS @20 , APPROX. 3mm THICK. 21.0-26.8 MASSIVE, NO PARTINGS, HARD, WELL INDURATED.
	25	NX	4	93/87.5			25.5, 27.65, 30.4, 31.2, 31.65 CORE BREAKS. 26.1 JT., 20°, ROUGH, FeO, TR. CALCITE. 26.8-30.0 V.THIN LAM. TO X-LAM. 27.2-27.7 3 CALCITE HEALED SHEARS-OFFSET APPROX. 3/4 IN. MAX. 28.3, 28.6 JT. (PARTINGS?) @20°, SMOOTH, IRREG., TR.FeO STAIN, SL. CALCITE. END OF BORING AT 33 FT.

LEGEND / NOTES

1. DATUM IS MDC SEWER DATUM (MDC=USGS+105.62 FT)
2. ▽ GROUND WATER LEVEL
3. BLOWS REQUIRED TO DRIVE 2" O.D. SAMPLE SPOON 6" OR DISTANCE SHOWN USING 140lb. HAMMER FALLING 30". * INDICATES USE OF 300lb. HAMMER. ( ) INCHES OF SAMPLE RECOVERY.
4. % ROCK CORE RECOVERY/ ROCK QUALITY DESIGNATION.
5. STD. PENETRATION RESISTANCE BLOWS/FT.
6. UNIFIED SOIL CLASSIFICATION SYSTEM.
7. SS = SPLIT SPOON
   NX = 2 IN. DIAMETER ROCK CORE

BORING LOG

DEER ISLAND SECONDARY TREATMENT FACILITY

STONE & WEBSTER ENG. CORP.
SKETCH No.

APPROVED	DATE	BORING NO.	SHEET
W Keller	2-12-87	02	1 OF 1

SITE DEER ISLAND SECONDARY TREATMENT FACILITY J.O. NO. 16100.08

SHEET 1 OF 1

COORDINATES 42°20.17′ 70°52.23′ GROUND ELEV. (1) APPROX. +60 FT.

INCLINATION VERTICAL BEARING ---- INSPECTOR W. Olszewski

DATE : START / FINISH 12-29-86 / 12-29-86 CONTRACTOR / DRILLER WARREN GEORGE/MARNEY

STATIC GROUNDWATER DEPTH / DATE -- (FT) / -- DRILL RIG TYPE DIEDRICH D50

DEPTH TO BEDROCK 4.8 (FROM SEA BOTTOM) (FT) TOTAL DEPTH DRILLED 21.2 (FT)

METHODS :

DRILLING SOIL ROLLER BIT TO 5 FT

SAMPLING SOIL SPLIT SPOON AT 5 FT INTERVALS

DRILLING ROCK ROLLER BIT 5 FT TO 8 FT. NX CORE 8 FT TO 21 FT.

SPECIAL TESTING OR INSTRUMENTATION

COMMENTS WATER DEPTH 44 FT

ELEVATION (FEET)(1&2)	DEPTH (FEET)	SAMPLE TYPE (7)	SAMPLE NUMBER	BLOWS (3) OR REC/RQD (4)	SPT N VALUE (5)	GROUP SYMBOL (6)	SAMPLE DESCRIPTION
60		SS	1	22/19/ 19/25	38	SM	SILTY SAND. WIDELY GRADED, 15-25% ANGULAR GRAVEL, COARSE TO FINE SAND, 15-25% NONPLASTIC FINES, BROWN-GRAY, NUMEROUS SHELL FRAGMENTS.
							TOP OF ROCK AT 4.8 FT
	5						(ROLLER BIT TO 8.25 FT)
		SS	2	58/44/ 82/28	126	—	MEDIUM TO DARK GRAY ARGILLITE, VERY THINLY LAMINATED AT 30°, FRESH, MODERATELY HARD TO HARD, PARTINGS AT 1 FT TO 2.5 FT. SMOOTH TO SLIGHTLY ROUGH WITH TRACE OF CALCITE COATING.
50	10	NX	1	60/44			8.25 FT TO 9.75 FT-CORE SEVERELY BROKEN DUE TO DISKING/SLIGHTLY WEATHERED.
	15	NX	2	93/93			15.8 TO 19.65 FT-BEDDING VARIABLE FROM HORIZONTAL TO 60°, OFTEN CONTORTED, CRENULATED.
							19.65 FT TO TOTAL DEPTH-BEDDING AT 35°.
							19.7 TO 20.2 FT-JOINT AT 75°, SMOOTH TO SLIGHTLY ROUGH, FRESH.
40	20						
							END OF BORING AT 21.2 FT
	25						
30	30						

LEGEND / NOTES

1. DATUM IS MDC SEWER DATUM (MDC = USGS+105.62 FT)
2. ▽ GROUND WATER LEVEL
3. BLOWS REQUIRED TO DRIVE 2" O.D. SAMPLE SPOON 6" OR DISTANCE SHOWN USING 140lb. HAMMER FALLING 30". * INDICATES USE OF 300lb. HAMMER. ( ) INCHES OF SAMPLE RECOVERY.
4. % ROCK CORE RECOVERY/ ROCK QUALITY DESIGNATION.
5. STD. PENETRATION RESISTANCE BLOWS/FT.
6. UNIFIED SOIL CLASSIFICATION SYSTEM.
7. SS = SPLIT SPOON. NX = 2 IN. DIAMETER ROCK CORE.

BORING LOG

DEER ISLAND SECONDARY TREATMENT FACILITY

MWRA

STONE & WEBSTER ENG. CORP.

APPROVED	DATE	BORING NO.	SHEET
WKelker	2-12-87	03	1 OF 1

COORDINATES 70°57.51'W 42°20.04'N GROUND ELEV. (1) APPROX. +68 FT

SHEET 1 OF 2

INCLINATION VERTICAL BEARING ______ INSPECTOR OLSZEWSKI

DATE : START / FINISH 12-27-86 / 12-28-86 CONTRACTOR / DRILLER WARREN GEORGE/MARNEY

STATIC GROUNDWATER DEPTH / DATE - (FT) / - DRILL RIG TYPE DIEDRICH D-50

DEPTH TO BEDROCK 76 (FROM SEA BOTTOM) (FT) TOTAL DEPTH DRILLED 80 (FT)

METHODS :

DRILLING SOIL ROLLER BIT

SAMPLING SOIL SPLIT SPOON AT 5.0 FT INTERVALS. OSTERBERG AT 6 FT

DRILLING ROCK ROLLER BIT ONLY. LOWER SECTION OF HOLE ADVANCED OUT OF VERTICAL DUE TO BARGE MOVEMENT FROM TIDAL CURRENTS. CORE BARREL WOULD NOT ADVANCE.

SPECIAL TESTING OR INSTRUMENTATION ______

COMMENTS WATER DEPTH: 35 FT TO 40 FT (TIDAL VARIATION)

ELEVATION (FEET)(F...)	DEPTH (FEET)	SAMPLE TYPE (7)	SAMPLE NUMBER	BLOWS (3) OR REC/RQD (4)	SPT N VALUE (5)	GROUP SYMBOL (6)	SAMPLE DESCRIPTION
68	0	SS	1	WOR	—	CL CH	SILTY CLAY, MODERATELY TO HIGHLY PLASTIC, FIRM UNDISTURBED, BECOMES VERY SOFT REMOLDED GREEN GRAY.
	5						
		UO	2	—	—	CL CH	SILTY CLAY, SAME AS ABOVE.
60							
	10						
		SS	3	WOR	—	CL CH	SILTY CLAY, SAME AS ABOVE.
	15	SS	4	WOH	—	CL CH	SILTY CLAY, SAME AS ABOVE.
50							
	20	SS	5	WOH	—	CL CH	SILTY CLAY, SAME AS ABOVE.
	25	SS	6	WOH	—	CL CH	SILTY CLAY, SAME AS ABOVE.
40							
	30						

LEGEND / NOTES

1. DATUM IS MDC SEWER DATUM (MDC=USGS+105.62 FT)
2. ▽ GROUND WATER LEVEL
3. BLOWS REQUIRED TO DRIVE 2" O.D. SAMPLE SPOON 6" OR DISTANCE SHOWN USING 140lb. HAMMER FALLING 30". * INDICATES USE OF 300lb. HAMMER. ( ) INCHES OF SAMPLE RECOVERY.
4. % ROCK CORE RECOVERY/ ROCK QUALITY DESIGNATION.
5. STD. PENETRATION RESISTANCE BLOWS/FT.
6. UNIFIED SOIL CLASSIFICATION SYSTEM.
7. SS = SPLIT SPOON
   UO = UNDISTURBED OSTERBERG.
   NX = 2 IN. DIAMETER ROCK CORE.

BORING LOG

DEER ISLAND SECONDARY TREATMENT FACILITY

MWRA

STONE & WEBSTER ENG. CORP.
SKETCH No.

APPROVED	DATE	BORING NO.	SHEET
WKilher	2-12-87	T1	1 OF 2

BORING NO. T1

SHEET 2 OF 2

SITE DEER ISLAND SECONDARY TREATMENT FACILITY J.O. NO. 16100.08

ELEVATION (FEET)(1&2)	DEPTH (FEET)	SAMPLE TYPE (7)	SAMPLE NUMBER	BLOWS (3) OR REC/RQD (4)	SPT N VALUE (5)	GROUP SYMBOL (6)	SAMPLE DESCRIPTION
38	30	SS	7	WOR	—	CL CH	SILTY CLAY, SAME AS ABOVE.
	35	SS	8	WOH	—	CL CH	SILTY CLAY, SAME AS ABOVE.
30							
	40	SS	9	WOR	—	CL CH	SILTY CLAY, SAME AS ABOVE.
	45	SS	10	WOR	—	CL CH	SILTY CLAY, SAME AS ABOVE.
20							
	50	SS	11	30-50-36-36	86	CL ML	SANDY CLAY, SLIGHTLY PLASTIC, 25-35% COARSE TO FINE SAND, 20-30% GRAVEL TO 1.0" MAXIMUM, BROWN GRAY.
	55	NX	12	—	—	—	RECOVERY LIMITED TO SEVERAL PIECES OF 1/2"-1-1/2" ROCK (MAINLY ARGILLITE).
10							
	60	NX	13	—	—	—	SIMILAR TO ABOVE.
	65	SS	14	34-29-25-25	54	SC	CLAYEY SAND, WIDELY GRADED, 10-15% ANGULAR GRAVEL TO 0.5" MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM SAND, 15-25% SLIGHTLY PLASTIC FINES, GRAY.
0							
	70	SS	15	110/6" 19-12-21 (300# HAMMER)	—	GC	GRAVELLY CLAY, SLIGHTLY PLASTIC (BASED ON 1" RECOVERY).
	75						TOP OF ROCK AT 76 FT.
-10							MEDIUM TO DARK GRAY ARGILLITE, (DESCRIPTION BASED ON ROLLER BIT CUTTINGS. SEE PAGE 1 DRILLING ROCK COMMENTS.)
	80						END OF BORING AT 80 FT.
	85						
-20							

NOTE: FOR BORING SUMMARY AND LEGEND INFO. SEE SHEET 1.

STONE & WEBSTER ENG. CORP. SKETCH No.

APPROVED	DATE	BORING NO.	SHEET
W Kilton	2-12-87	T1	2 OF 2

SITE DEER ISLAND SECONDARY TREATMENT FACILITY   J.O. NO. 16100.08

BORING NO. T2
SHEET 1 OF 2

COORDINATES 70°57.50'W   42°18.06'N   GROUND ELEV. (1) APPROX. +80 FT

INCLINATION VERTICAL   BEARING --   INSPECTOR OLSZEWSKI/KILKER

DATE: START/FINISH 12-28-86 / 12-29-86   CONTRACTOR/DRILLER WARREN GEORGE/MARNEY

STATIC GROUNDWATER DEPTH/DATE - (FT) / -   DRILL RIG TYPE DIEDRICH D-50

DEPTH TO BEDROCK 40(FROM SEA BOTTOM) (FT)   TOTAL DEPTH DRILLED 59.5 (FT)

METHODS:

DRILLING SOIL ROLLER BIT. CASED TO 10 FT WITH 4 IN. CASING.

SAMPLING SOIL SPLIT SPOON AT 5.0 FT INTERVALS.

DRILLING ROCK INSTALLED 3 IN. CASING INSIDE 4 IN. TO 40 FT DEPTH. NX CORE 40 FT TO 59 FT.

SPECIAL TESTING OR INSTRUMENTATION ATTEMPTED UNDISTURBED SAMPLE AT 25 FT DEPTH. NO RECOVERY.

COMMENTS WATER DEPTH: 23 FT TO 30 FT (TIDAL VARIATION).

ELEVATION (FEET)(1&2)	DEPTH (FEET)	SAMPLE TYPE (7)	SAMPLE NUMBER	BLOWS (3) OR REC/RQD (4)	SPT N VALUE (5)	GROUP SYMBOL (6)	SAMPLE DESCRIPTION
80		SS	1	WOR	0	SM	SILTY SAND, MEDIUM TO FINE MOSTLY FINE, 20-30% NONPLASTIC FINES, GRAY BROWN, NUMEROUS SHELL FRAGMENTS.
	5						
		SS	2	7-7-10-12	17	CL-CH	SILTY CLAY, MODERATELY TO HIGHLY PLASTIC, VERY STIFF, LIGHT GREEN GRAY. (ADVANCE OF SPOON BLOCKED BY STONE RECOVERED IN BOOT.)
70	10						
		SS	3	4-4-6-6	10	CL-CH	SILTY CLAY, MODERATELY PLASTIC, STIFF TO VERY STIFF, LIGHT GREEN GRAY.
	15	SS	4	WOR	0	CL-CH	SILTY CLAY, SIMILAR TO ABOVE, EXCEPT SOFT.
60	20	SS	5	WOR-5-6-7	11	CL-CH	SILTY CLAY, MODERATELY TO HIGHLY PLASTIC, STIFF GRAY.
	25	SS	6	23-14-23-17	37	GL-CL	GRAVELLY SANDY CLAY, SLIGHTLY TO MODERATELY PLASTIC, 10-20% GRAVEL TO 1/2" (2 PIECES TO 1"), 15-20% FINE SAND, VERY HARD, GRAY.
50	30						

LEGEND / NOTES

1. DATUM IS MDC SEWER DATUM (MDC=USGS+105.62 FT).
2. ▽ GROUND WATER LEVEL
3. BLOWS REQUIRED TO DRIVE 2" O.D. SAMPLE SPOON 6" OR DISTANCE SHOWN USING 140lb. HAMMER FALLING 30". * INDICATES USE OF 300lb. HAMMER. ( ) INCHES OF SAMPLE RECOVERY.
4. % ROCK CORE RECOVERY/ ROCK QUALITY DESIGNATION.
5. STD. PENETRATION RESISTANCE BLOWS/FT.
6. UNIFIED SOIL CLASSIFICATION SYSTEM.
7. SS = SPLIT SPOON
   UO = UNDISTURBED OSTERBERG
   NX = 2 IN. DIAMETER ROCK CORE

BORING LOG

DEER ISLAND SECONDARY TREATMENT FACILITY

MWRA

STONE & WEBSTER ENG. CORP.
SKETCH No.

APPROVED	DATE	BORING NO.	SHEET
W Kilker	2-12-87	T2	1 OF 2

BORING NO.	T2
SHEET 2 OF	2

SITE DEER ISLAND SECONDARY TREATMENT FACILITY J.O. NO. 16100.08

ELEVATION (FEET)(1&2)	DEPTH (FEET)	SAMPLE TYPE (7)	SAMPLE NUMBER	BLOWS (3) OR REC/RQD (4)	SPT N VALUE (5)	GROUP SYMBOL (6)	SAMPLE DESCRIPTION
50	30	SS	7	28-26-34-28	60	SC	GRAVELLY SILTY SAND, WIDELY GRADED, 35-40% GRAVEL, COARSE TO FINE SAND, 15-20% SLIGHTLY PLASTIC FINES, VERY DENSE, GRAY.
	35	SS	8	21-100/3"	100	CL-ML	SANDY CLAY, NONPLASTIC TO SLIGHTLY PLASTIC, 10-20% FINE SAND, 3 PIECES DARK GRAY ARGILLITE, HARD, GRAY.
							TOP OF ROCK AT 40 FT.
40	40						DK. BROWN-GRAY ARGILLITE, MASSIVE TO V. THIN LAM. (FAINT)@HOR. TO 50°, FRESH MOD. HARD, FINE SAND OCCURS AS OCCAS. BEDS, IRREG. MASSES AND DISSEMINATED GRAINS, OCCAS. CALCITE FILLED STRINGERS (1-2mm THICK) @50°-70°. 40.2-40.7 JT. @ 80°, SMOOTH TO SL. ROUGH, SL. CALC. COATING. 41.0 JT. SUBHOR., IRREG., SL. CLAY FILM.
	45	NX	1	73/33			41.9-43.0 JT., SUBVERT. SMOOTH TO ROUGH, CALC. COATED. 43.0 JT. @45°, ROUGH, IRREG., SL. CLAY FILM. 43.8 JT. @50°, SL. ROUGH, IRREG., CALC. COAT. 44.2 JT. @50°, SL. ROUGH, IRREG., SL. CLAY. 44.7 FRAC. @50°, ROUGH, IRREG., CLAY COAT. 44.7-45.2 BEDDING IRREG., CONTORTED W/ UP TO 90% FINE SAND IN LOCAL CONCENTRATIONS.
30	50						45.5 JT. @50°, SL. ROUGH, IRREG., CLAY COAT.
	55	NX	2	99/74			49.5 JT. @50°, SMOOTH TO SL. ROUGH, IRREG., CALC. COAT. 49.7 JT. @50°, SL. ROUGH, SL. CLAY, FeO STAIN. 49.0-51.4 BEDDING IRREG. CONTORTED W/FINE SAND LAMS. AND IRREG. MASSES, V. THIN DISCONTINUOUS CALC. STRINGERS. 51.4 JT. @ 50° , ROUGH, CLAY COAT. 51.4 TO 56.8 LAM. @40°. 51.9 JT. SUBHOR., SL. ROUGH, CLAY COAT. 55.3 JT. @50°, ROUGH, SL. CLAY FILM. 56.7—T.D. MASSIVE, SILTY, LAM. OBSCURE.
20	60						56.6 - 58.2 JT., SUBVERT., SL. ROUGH, IRREG., CALC. FILLED.
							END OF BORING AT 59.5 FT.

NOTE: FOR BORING SUMMARY AND LEGEND INFO. SEE SHEET 1.	STONE & WEBSTER ENG. CORP. SKETCH No.	APPROVED W Kilian	DATE 2-12-87	BORING NO. T2	SHEET 2 OF 2

WATER RESOURCES AUTHORITY
MASSACHUSETTS